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THE MONIST

ON THE PSYCHOLOGY AND NATURAL DEVELOPMENT OF GEOMETRY.[1]

I.

FOR the animal organism, the relations of the different parts of *its own body* to one another and of physical objects to these different parts are *primarily* of the greatest importance. Upon these relations is based its system of physiological sensations of space. More complicated conditions of life, in which the simple and direct satisfaction of needs is impossible, result in an augmentation of intelligence. The physical, and particularly the *spatial*, behavior of bodies *toward one another* may then acquire a mediate and indirect interest far transcending the interest of the momentary sensations. In this way, a spatial image of the world is created, at first instinctively, then in the practical arts, and finally scientifically, in the form of geometry. The mutual relations of bodies are geometrical in so far as they are determined by sensations of space, or find their expression in such sensations. Just as without sensations of heat there would have been no theory of heat, so also there would be no geometry without sensations of space; but both the theory of heat and geometry stand in additional need of *experiences concerning bodies;* that is to say, they must both *go out beyond* the narrow boundaries of the domain of sense that constitutes their peculiar foundation.

Isolated sensations have *independent* significance only in the

[1] Translated from Professor Mach's manuscript by Thomas J. McCormack.

lowest stages of animal life; as, for example, in reflex motions, in the removal of some disagreeable irritation of the skin, in the snapping reflex of the frog, etc. In the higher stages, attention is directed, not to space-sensation alone, but to those intricate and intimate *complexes* of other sensations with space-sensations which we call *bodies*. Bodies arouse our interest; they are the *objects* of our activities. But the *character* of our activities is coincidently determined by the *place* of the body, whether near or far, whether above or below, etc.,—in other words, *by the space-sensations characterising it*. The *mode* of reaction is thus determined by which the body can be reached, whether by extending the arms, by a few or many steps, by hurling missiles, or what not. The *quantity* (*number*) of sensitive elements which a body excites, the number of places which it covers, that is to say, the *volume* of the body, is, all other things being the same, proportional to its capacity for satisfying our needs, and possesses consequently a biological import. Although our sensations of sight and touch are primarily produced only by the *surfaces* of bodies, nevertheless powerful associations impell primitive man especially to imagine more, or, as he thinks, to *perceive* more, than he actually observes. He imagines to be filled with *matter* the places enclosed by the surface which alone he perceives; and this is especially the case when he sees or seizes bodies with which he is in some measure familiar. It requires considerable power of abstraction to bring to consciousness the fact that we perceive the surface *only* of bodies—a power which cannot be ascribed to primitive man.

Of importance in this regard are also the peculiar *distinctive shapes* of objects of prey and utility. Certain definite forms, that is, certain specific combinations of space-sensations, which man learns to know through intercourse with his environment, are unequivocally characterised even by purely physiological features. The straight line and the plane are distinguished above other forms by their physiological simplicity, as are likewise the circle and the sphere. The affinity of symmetric and geometrically similar forms is revealed by purely physiological properties. The variety of shapes with which we are acquainted from our phys-

iological experience is far from being inconsiderable. Finally, through employment with bodily objects, *physical* experience also contributes its quota of wealth to the general store.

Crude physical experience impels us to attribute to bodies a certain *constancy*. Unless there are special reasons for not doing so, the same constancy is also ascribed to the individual attributes of the complexus "body." We also regard the color, hardness, shape, etc., of the body as constant; particularly we look upon the body as *constant with respect to space, as indestructible*. This assumption of spatial constancy, of *spatial substantiality*, finds its direct expression in geometry. Our physiological and psychological organisation is independently predisposed to emphasise constancy; inasmuch as general physical constancies must necessarily have found lodgment in our organisation, which is itself physical, while in the adaptation of the species very definite physical constancies were at work. Since memory revives the images of bodies before perceived in their original forms and dimensions, it supplies the condition for the recognition of the same bodies, thus furnishing the first foundation for the impression of constancy. But geometry is still in need of certain individual experiences.

Let a body K move away from an observer A by being suddenly transported from the environment FGH to the environment MNO. To the optical observer A the body K decreases in size and assumes generally a different form. But to an optical observer B who moves along with K and retains the same position with respect to K, K remains unaltered. An analogous sensation is experienced by the *tactual observer*, although the perspective diminution is here wanting for the reason that the sense of touch is not a telepathic sense. The experiences of A and B must now be harmonised and their contradictions eliminated,—a requirement which becomes especially imperative when *the same* observer plays alternately the part of A and of B. And the only method by which they can be harmonised is to attribute to K certain *constant* spatial properties independently of its position with respect to *other* bodies. The space-sensations determined by K in the observer A are recognised as *dependent* on other space-sensations (the position of K with

respect to the body of the observer *A*). But these same space-sensations determined by *K* in *A* are *independent* of other space-sensations, characterising the position of *K* with respect to *B*, or with respect to *FGH* . . . *MNO*. In *this* independence lies the *constant* with which we are here concerned. The fundamental assumption of geometry thus reposes on an *experience*, although of the idealised kind.

For the experiences in question to assume conspicuous and perfectly determinate form the body *K* must be a so-called *rigid* body. If the space-sensations associated with *three* distinct acts of sense-perception remain unaltered, then the condition is given for the invariability of the entire complexus of space-sensations determined by a rigid body. This determination of the space-sensations produced by a body by means of *three* space-sensational *elements* accordingly characterises the rigid body from the point of view of the physiology of the senses. This holds good for both the visual and the tactual sense. In employing this designation we are not thinking of the physical conditions of rigidity, in defining which we should be compelled to enter different sensory domains, but of the fact given merely to our spatial sense. Indeed, we are now regarding every body as rigid which possesses the property assigned, even liquids, as long as their parts are not in motion with respect to one another.

Correct as the oft-repeated contention is that geometry is concerned, not with *physical*, but with *ideal* objects, it nevertheless cannot be doubted that geometry has sprung from the interest centring in the spatial relations of *physical bodies*. It bears the distinctest marks of this origin, and the course of its development is fully intelligible only on a consideration of these traces. Our knowledge of the spatial behavior of bodies is based upon the *comparison* of the space-sensations produced by them. Even without the least artificial or scientific assistance we acquire abundant experience of space. We can judge approximately whether rigid bodies which we perceive alongside one another in different positions at different distances, will, when brought *successively* into the same position, produce approximately the same or dissimilar

space-sensations. We know pretty well whether one body will coincide with another, whether a pole lying flat on the ground will reach to a certain height. Our sensations of space are, however, subject to physiological circumstances which can never be absolutely identical for the members compared. In every case, rigorously viewed, a memory-trace of a sensation is necessarily compared with a real sensation. If, therefore, it is a question of the exact spatial relationship of bodies *to one another*, we must provide characteristics that depend as little as possible on the physiological conditions, so difficult to control. This is accomplished by comparing *bodies* with *bodies*. Whether a body *A* coincides with another body *B*, whether it can be made to occupy exactly the space filled by the other, that is, whether under like circumstances both bodies produce the same space-sensations, can be estimated with great precision. We regard such bodies as spatially or geometrically equal in every respect,—*as congruent*. The *character* of the sensations is here no longer authoritative; it is now solely a question of their *equality* or *inequality*. If both bodies are rigid bodies, we can apply to the second body *B* all the experiences which we have gathered in connection with the first, more convenient, and more easily transportable, standard body *A*. We shall revert later to the circumstance that it is neither necessary nor possible to employ a special body of comparison, or standard, for every body. The most convenient bodies of comparison, though applicable only after a crude fashion,—bodies whose invariance during transportation we always have before our eyes,—are our *hands* and *feet*, our *arms* and *legs*. The names of the oldest measures show distinctly that originally we made our measurements with hand-breadths, forearms (*ells*), feet (*paces*), etc. Nothing but a period of *greater exactitude* in measurement began with the introduction of conventional and carefully preserved physical standards; the principle remains the same. The measure enables us to compare bodies which are difficult to move or practically immovable.

As has been remarked, it is not the *spatial*, but predominantly the *material*, properties of bodies that possess the strongest interest. This fact certainly finds expression even in the beginnings of

geometry. The *volume* of a body is instinctively taken into account as representing the quantity of its material properties, and so comes to form an object of *contention* long before its geometric properties receive anything approaching to profound consideration. It is here, however, that the comparison, the measurement of volumes acquires its initial import, and thus takes its place among the first and most important problems of primitive geometry. The first measurements of volume were doubtless of liquids and fruit, and were made with hollow measures. The object was to ascertain conveniently the quantity of like matter, or the *quantity* (*number*) of homogeneous, similarly-shaped (identical) *bodies*. Thus, conversely, the capacity of a store-room (granary) was in all likelihood originally estimated by the quantity or number of homogeneous bodies which it was capable of containing. The measurement of volume by a unit of volume is in all probability a much later conception, and can only have developed on a higher stage of abstraction. Estimates of areas were also doubtless made from the *number* of fruit-bearing or useful plants which a field would accommodate, or from the quantity of seed that could be sown on it; or possibly also from the *labor* which such work required. The measurement of a surface by a surface was readily and obviously suggested in this connection when fields of the same size and shape lay near one another. There one could scarcely doubt that the field made up of n fields of the same size and form possessed also n-fold agricultural value. We shall not be inclined to underrate the significance of this intellectual step when we consider the errors in the measurement of areas which the Egyptians[1] and even the Roman *agrimensores*[2] commonly committed. Even with a people so splendidly endowed with geometrical talent as the Greeks, and in a late period, we meet with the sporadic expression of the idea that surfaces having equal perimeters were equal in area.[3] When the Persian "Overman," Xerxes,[4] wished to count the army which he had to "feed,"

[1] Eisenlohr, *Ein mathematisches Handbuch der alten Aegypter: Papyrus Rhind*, Leipsic, 1877.

[2] M. Cantor, *Die römischen Agrimensoren*, Leipsic, 1875.

[3] Thucydides, VI., 1.

[4] Herodotus, VII., 22, 56, 103, 223.

and which he drove under the lash across the Hellespont against the Greeks, he adopted the following procedure: 10,000 men were drawn up closely packed together. The area which they covered was surrounded with an enclosure, and each successive division of the army, or rather, herd of slaves, that was driven into and filled the pen, counted for another 10,000. We meet here with the converse application of the idea by which a surface is measured by the *quantity (number) of equal, identical, immediately adjacent bodies which cover it.* In abstracting, first instinctively and then consciously, from the height of these bodies, the transition is made to measuring surfaces by means of a unit of surface. The analogous step to measuring volumes by volume demands a far more practiced, geometrically schooled intuition. It is effected later and is even at this day less easy to the masses.

The oldest estimates of long *distances*, which were computed by day's journeys, hours of travel, etc., were doubtless based upon the effort, labor, and expenditure of time necessary for covering these distances. But when lengths are measured by the repeated application of the hand, the foot, the arm, the rod, or the chain, then, accurately viewed, the measurement is made by the enumeration of like bodies, and we have again really a measurement of volume. The singularity of this conception will disappear in the course of this exposition. If, now, we abstract, first instinctively and then consciously, from the two transverse dimensions of the bodies employed in the enumeration, we reach the measuring of a line by a line.

A surface is commonly defined as the boundary of a space. Thus, the surface of a metal sphere is the boundary between the metal and the air; it is not part either of the metal or of the air; two dimensions only are ascribed to it. Analogously, the one-dimensional line is the boundary of a surface; for example, the equator is the boundary of the surface of a hemisphere. The dimensionless point is the boundary of a line; for example, of the arc of a circle. A point, by its motion, generates a one-dimensional line, a line a two-dimensional surface, and a surface a three-dimensional solid space. No difficulties are presented by this concept to minds at

all skilled in abstraction. It suffers, however, from the drawback that it does not exhibit, but on the contrary artificially conceals, the natural and actual way in which the abstractions have been reached. A certain discomfort is therefore felt when the attempt is made from this point of view to define the measure of surface or unit of area after the measurement of lengths has been discussed.[1]

A more homogeneous conception is reached if *every* measurement be regarded as a counting of space by means of immediately *adjacent*, spatially *identical*, or at least hypothetically identical, *bodies*, whether we be concerned with volumes, with surfaces, or with lines. Surfaces may be regarded as corporeal sheets, having everywhere the same constant thickness which we may make small at will, *vanishingly* small; lines, as strings or threads of constant, vanishingly small thickness. A point then becomes a small corporeal space from the extension of which we purposely abstract, whether it be part of another space, of a surface, or of a line. The bodies employed in the enumeration may be of any smallness or any form which conforms to our needs. Nothing prevents our idealising in the usual manner these images, reached in the natural way indicated, by simply leaving out of account the thickness of the sheets and the threads. The usual and somewhat timid mode of presenting the fundamental notions of geometry is doubtless due to the fact that the infinitesimal method which freed mathematics from the historical and accidental shackles of its early elementary form, did not begin to influence geometry until a later period of development, and that the frank and natural alliance of geometry with the *physical* sciences was not restored until still later, through Gauss. But why the elements shall not now partake of the advantages of our better insight, is not to be clearly seen. Even Leibnitz adverted to the fact that it would be more rational to begin with the *solid* in our geometrical definitions.[2]

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[1] Hölder, *Anschauung und Denken in der Geometrie*, Leipsic, 1900, p. 18. W. Killing, *Einführung in die Grundlagen der Geometrie*, Paderborn, 1898, II., p. 22, et seq.

[2] Letter to Vitale Giordano, *Leibnizens mathematische Schriften*, edited by Gerhardt, Section I., Vol. I., page 199.

The measurement of spaces, surfaces, and lines by means of *solids* is a conception from which our refined geometrical methods have become entirely estranged. Yet this idea is not merely the forerunner of the present idealised methods, but it plays an important part in the psychology of geometry, and we find it still powerfully active at a late period of development in the workshop of the investigator and inventor in this domain. Cavalieri's Method of Indivisibles appears best comprehensible through this idea. Taking his own illustration, let us consider the surfaces to be compared (the quadratures) as covered with equidistant parallel threads of any number we will, after the manner of the warp of woven fabrics, and the spaces to be compared (the cubatures) as filled with parallel sheets of paper. The total *length* of the threads may then serve as measure of the *surfaces*, and the total *area* of the sheets as measure of the *volumes*, and the accuracy of the measurement may be carried to any point we wish. The number of *like equidistant* bodies, if close enough together and of the right form, can just as well furnish the numerical measures of surfaces and solid spaces as the number of identical bodies absolutely covering the surfaces or absolutely filling the spaces. If we cause these bodies to shrink until they become lines (straight lines) or until they become surfaces (planes), we shall obtain the division of surfaces into surface-elements and of spaces into space-elements, and coincidently the customary measurement of surfaces by surfaces and of spaces by spaces. Cavalieri's defective exposition, which was not adapted to the state of the geometry of his time, has evoked from the historians of geometry some very harsh criticisms of his beautiful and prolific procedure.[1] The fact that a Helmholtz, his critical judgment yielding in an unguarded moment to his fancy, could, in his great youthful work,[2] regard a surface as the sum of the lines (ordinates) contained in it, is merely proof of the great depth to which

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[1] Weissenborn, *Principien der höheren Analysis in ihrer Entwickelung*. Halle, 1856. Gerhardt, *Entdeckung der Analysis*. Halle, 1855, p. 18. Cantor, *Geschichte der Mathematik*. Leipsic, 1892, II. Bd.

[2] Helmholtz, *Erhaltung der Kraft*. Berlin, 1847, p. 14.

this original natural conception reaches, and of the facility with which it reasserts itself.[1]

II.

We have then, first, the general experience that *moveable bodies* exist, to which, in spite of their mobility, a certain *spatial constancy* in the sense above described, a permanently *identical property*, must be attributed,—a property which constitutes the foundation of all notions of measurement. But in addition to this there has been gathered instinctively, in the pursuit of the trades and the arts, a considerable variety of *special* experiences, which have contributed their share to the development of geometry. Appearing in part in unexpected form, in part harmonising with one another, and sometimes, when incautiously applied, even becoming involved in what appears to be paradoxical contradictions, these experiences disturb the course of thought and incite it to the pursuit of the or-

[1] The following simple illustration (Fig. 1) of Cavalieri's method may be helpful to readers not thoroughly conversant with geometry: Imagine a right circular cylinder of horizontal base cut out of a stack of paper sheets resting on a table, and conceive inscribed in the cylinder a cone of the same base and altitude. Whereas the sheets cut out by the cylinder are all equal, those forming the cone increase in size as the squares of their distances from the vertex. Now from elementary geometry we know that the volume of such a cone is one third that of the cylinder. This result may be applied at once to the quadrature of the parabola. Let a rectangle be described about a portion of a parabola, its sides coinciding with the axis and the tangent to the curve at the origin. Conceiving the rectangle to be covered with a system of threads running parallel to x, every thread of the rectangle will be divided into two parts, of which that lying outside the parabola is proportional to y^2. Therefore, the area outside the parabola is to the total area of the rectangle precisely as is the *volume* of the cone to that of the cylinder, viz., as 1 is to 3.

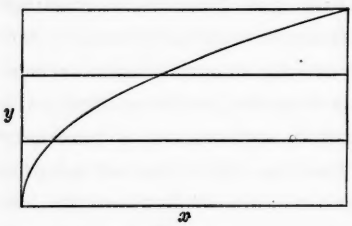

Fig. 1.

It is significant of the naturalness of Cavalieri's view that the writer of these lines, hearing of the higher geometry when a student at the Gymnasium, but without any training in it, lighted on very similar conceptions,—a performance not attended with any difficulty in the nineteenth century. By the aid of these he made a number of little discoveries, which were of course already long known, found Guldin's theorem, calculated some of Kepler's solids of rotation, etc.

derly logical connection of these experiences. We shall now devote our attention to some of these processes.

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Even though the well-known statement of Herodotus[1] were wanting, in which he ascribes the origin of geometry to land-surveying among the Egyptians; and even though the account were totally lost[2] which Eudemus has left regarding the early history of geometry, and which is known to us from an extract in Proclus, it would be impossible for us to doubt that a pre-scientific period of geometry existed. The first geometrical knowledge was acquired accidentally and without design in the way of practical experience, in connection with the most varied employments. It was gained at a time when the scientific spirit, or interest in the interconnection of the experiences in question, was but little developed. This is plain even in our meager history of the beginnings of geometry, but still more so in the history of primitive civilisation at large, where technical geometrical appliances are known to have existed at so early and barbaric a day as to exclude absolutely the assumption of scientific effort.

All savage tribes practice the art of weaving, and here, as in their drawing, painting, and wood-cutting, occur preferably ornamental themes consisting of the simplest geometrical forms. For such forms, like the drawings of our children, answer to the simplified, typical, schematic conception of the objects which they are

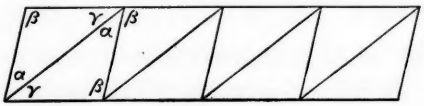

Fig. 2.

desirous of imitating, while it is also these forms which are most easily produced, with their primitive implements and manual dexterity. Such an ornament consisting of a series of similarly-shaped triangles alternately inverted, or ot a series of parallelograms (Fig. 2), clearly suggests the idea, that the sum of the three angles

[1] *Herodotus*, II., 109.

[2] James Gow, *A Short History of Greek Mathematics*, Cambridge, 1884, p. 134.

of a triangle, when their vertices are placed together, makes up two right angles. Also this fact could not possibly have escaped the clay and stone workers of Assyria, Egypt, Greece, etc., in constructing the customary mosaics and pavements from differently colored stones of the same shape. The theorem of the Pythagoreans that the plane space about a point can be completely filled by only three regular polygons, viz., by six equilateral triangles, by four squares, and by three regular hexagons, points to the same source.[1] A like origin is revealed also in the early Greek method of demonstrating the theorem regarding the angle-sum of any triangle by dividing it (by drawing the altitude) into two right-angled triangles and completing the rectangles corresponding to the parts so obtained.[2] The same experiences happen on many other occasions. If

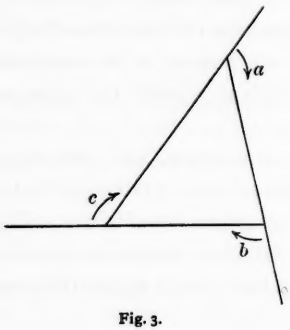

Fig. 3.

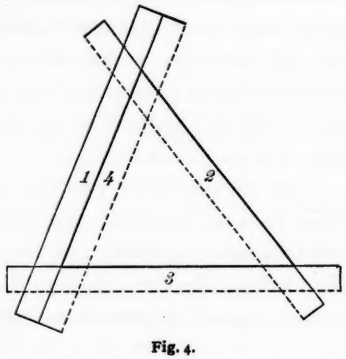

Fig. 4.

a surveyor walk round a polygonal piece of land, he will observe, on arriving at the starting-point, that he has performed a complete revolution, consisting of four right angles. In the case of a triangle, accordingly, of the six right angles constituting the interior and exterior angles (Fig. 3) there will remain, after subtracting the three exterior angles of revolution, *a*, *b*, *c*, two right angles as the sum of the interior angles. This deduction of the theorem was

[1] This theorem is attributed to the Pythagoreans by Proclus. Cf. Gow, *A Short History of Greek Mathematics*, p. 143, footnote.

[2] Hankel, *Geschichte der Mathematik*, Leipsic, 1874, p. 96.

employed by Thibaut,[1] a contemporary of Gauss. If a draughtsman draw a triangle by successively turning his ruler round the interior angles, always in the same direction (Fig. 4), he will find on reaching the first side again that if the edge of his ruler lay toward the outside of the triangle on starting, it will now lie toward the inside. In this procedure the ruler has swept out the interior angles of the triangle in the same direction, and in doing so has performed half a revolution.[2] Tylor[3] remarks that cloth or paper-folding may have led to the same results. If we fold a triangular piece of paper in the manner shown in Fig. 5, we shall obtain a double rectangle, equal in area to one half the triangle, where it will be seen that the sum of the angles of the triangle coinciding at *a* is two right angles. Although some very astonishing results may be obtained by paper-folding,[4] it can scarcely be assumed that these processes were *historically* very productive for geometry. The material is of too limited application, and artisans employed with it have too little incentive to exact observation.

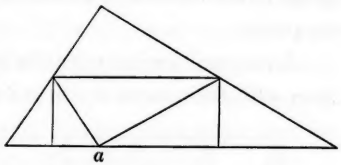

Fig. 5.

The knowledge that the angle-sum of the plane triangle is equal to a *determinate quantity*, namely, to two right angles, has thus been reached by experience, not otherwise than the law of the lever and Boyle and Mariotte's law of gases. It is true that neither the unaided eye nor measurements with the most delicate instruments can demonstrate *absolutely* that the sum of the angles of a plane triangle is *exactly* equal to two right angles. But the case is precisely the same with the law of the lever and with Boyle's law.

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[1] Thibaut, *Grundriss der reinen Mathematik*, Göttingen, 1809, p. 177. The objections which may be raised to this and the following deductions will be considered later.

[2] Noticed by the writer of this article while drawing.

[3] Tylor, *Anthropology, An Introduction to the Study of Man*, etc., German trans., Brunswick, 1883, p. 383.

[4] See, for example, Sundara Row's *Geometric Exercises in Paper-Folding*. Chicago: The Open Court Publishing Co. 1901.—*Tr.*

All these theorems are therefore idealised and schematised experiences; for real measurements will always show slight deviations from them. But whereas the law of gases has been proved by further experimentation to be approximate only and to stand in need of modification when the facts are to be represented with great exactness, the law of the lever and the theorem regarding the angle-sum of a triangle have remained in as exact accord with the facts as the inevitable errors of experimenting would lead us to expect; and the same statement may be made of all the consequences that have been based on these two laws as preliminary assumptions.

Equal and similar triangles placed in paving alongside one another with their bases *in one and the same straight line* must also have led to a very important piece of geometrical knowledge. (Fig. 6.) If a triangle be displaced in a plane along a straight line (without rotation), all its points, including those of its bounding lines, will describe equal paths. The same bounding line will furnish, therefore, in any two different positions, a system of two straight lines *equally distant* from one another at all points, and the operation coincidently vouches for the equality of the angles made by the line of displacement on corresponding sides of the two straight lines. The sum of the interior angles on the same side of the line of displacement was consequently determined to be two right angles, and thus Euclid's theorem of parallels was reached. We may add that the possibility of extending a pavement of this kind indefinitely, necessarily lent increased obviousness to this discovery. The sliding of a triangle along a ruler has remained to this day the simplest and most natural method of drawing parallel lines. It is scarcely necessary to remark that the theorem of parallels and the theorem of the angle-sum of a triangle are inseparably con-

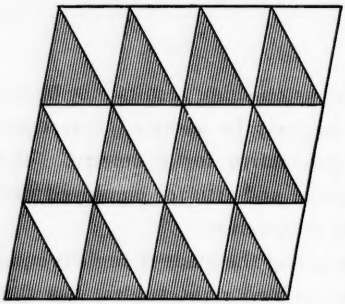

Fig. 6.

nected and represent merely different aspects of the same experience.

The stone masons above referred to must have readily made the discovery that a regular hexagon can be composed of equilateral triangles. Thus resulted immediately the simplest instances of the division of a circle into parts,—namely its division into six parts by the radius, its division into three parts, etc. Every carpenter knows instinctively and almost without reflection that a beam of rectangular symmetric cross-section may, owing to the perfect symmetry of the circle, be cut out from a cylindrical tree-trunk in an infinite number of different ways. The edges of the beam will all lie in the cylindrical surface, and the diagonals of a section will pass through the center. It was in this manner, according to Hankel[1] and Tylor,[2] that the discovery was probably made that all angles inscribed in a semicircle are right angles.

A stretched thread furnishes the distinguishing *visualisation* of the *straight line.* The straight line is characterised by its physiological simplicity. All its parts induce the *same* sensation of direction; every point evokes the mean of the space-sensations of the neighboring points; every part, however small, is similar to every other part, however great. But, though it has influenced the definitions of many writers,[3] the geometer can accomplish little with this physiological characterisation. The visual image must be enriched by physical experience concerning corporeal objects to be geometrically available. Let a string be fastened by one extremity at A, and let its other extremity be passed through a ring fastened at B. If we pull on the extremity at B, we shall *see* parts of the string which before lay between A and B pass out at B, while at the same time the string will approach the form of a straight line. A smaller number of like parts of the string, *identical bodies*, suffices to compose the straight line joining A and B than to compose a curved line. It is erroneous to assert that the straight line is recognised as the shortest line *by mere visualisation.* It is quite true we can, so far as quality is concerned, reproduce in *imagination* with perfect

[1] *Loc. cit.*, pp. 206–207. [2] *Loc. cit.* [3] Euclid, *Elements*, I., Definition 3.

accuracy and reliability, the simultaneous change of form and length which the string undergoes. But this is nothing more than a reviviscence of a *prior experience with bodies,—an experiment in thought.* The mere *passive contemplation of space* would never lead to such a result. Measurement is experience involving a physical reaction, a superposition-experiment. Visualised or imagined lines having different directions and lengths cannot be applied to one another forthwith. The possibility of such a procedure must be actually experienced with material objects accounted as unalterable. It is erroneous to attribute to animals an instinctive knowledge of the straight line as the shortest distance between two points. If a stimulus attract an animal's attention, and if the animal has so turned that its plane of symmetry passes through the stimulating object, then the straight line is the path of motion *uniquely* determined by the stimulus. This is distinctly shown in Loeb's investigations on the tropisms of animals.

Further, visualisation alone does not prove that any two sides of a triangle are together greater than the third side. It is true that if the two sides be laid upon the base by rotation round the vertices of the basal angles, it will be seen by an act of *imagination* alone that the two sides with their free ends moving in arcs of circles will ultimately overlap, thus more than filling up the base. But we should not have attained to this representation had not the procedure been actually witnessed in connection with corporeal objects. Euclid[1] deduces this truth circuitously and artificially from the fact that the greater side of every triangle is opposite to the greater angle. But the source of our knowledge here also is experience,—experience of the motion of the side of a physical triangle; this source has, however, been laboriously concealed by the form of the deduction,—and this not to the enhancement of perspicuity and brevity.

But the properties of the straight line are not exhausted with the preceding empirical truths. If a wire of any arbitrary shape be laid on a board in contact with two upright nails, and slid along

[1] Euclid, *Elements*, Book I., Prop. 20.

so as to be always in contact with the nails, the form and position of the parts of the wire between the nails will be constantly changing. The straighter the wire is, the slighter the alteration will be. A straight wire submitted to the same operation slides *in itself.* Rotated round two of its own fixed points, a crooked wire will keep constantly changing its position, but a straight wire will maintain its position, it will rotate within itself.[1] When we define, now, a straight line as the line which is completely determined by two of its points, there is nothing in this *concept* except the *idealisation* of the empirical notion derived from the physical experience mentioned,—a notion by no means directly furnished by the physiological act of visualisation.

The plane, like the straight line, is physiologically characterised by its simplicity. It appears the same at all parts.[2] Every point evokes the mean of the space-sensations of the neighboring points. Every part, however small, is like every other part, however great. But experiences gained in connection with physical objects are also required, if these properties are to be put to geometrical account. The plane, like the straight line, is physiologically symmetrical with respect to itself, if it coincides with the median plane of the body or stands at right angles to the same. But to discover that symmetry is a *permanent* geometrical property of the plane and the straight line, both constructs must be given as moveable, unalterable physical objects. The connection of physiological symmetry with metrical properties is in need also of special metrical demonstration.

Physically a plane is constructed by rubbing three bodies together until three surfaces, *A*, *B*, *C*, are obtained, each of which exactly fits the others,—a result which can be accomplished, as Fig. 7 shows, with neither convex nor concave surfaces, but with

[1] In a letter to Vitale Giordano (*Leibnizens mathematische Schriften, herausgegeben v. Gerhardt, erste Abtheilung, Bd. I., S.* 195-196), Leibnitz makes use of the above-mentioned property of a straight line for its definition. The straight line shares the property of displaceability in itself with the circle and the circular cylindrical spiral. But the property of rotatability within itself and that of being determined by *two* points, are exclusively its own.

[2] Compare Euclid, *Elements* I., Definition 7.

plane surfaces only. The convexities and concavities are, in fact, removed by the rubbing. Similarly, a truer straight line can be obtained with the aid of an imperfect ruler, by first placing it with its ends against the points *A*, *B*, then turning it through an angle of 180° out of its plane and again placing it against *A*, *B*, afterwards taking the *mean* between the two lines so obtained as a more perfect straight line, and repeating the operation with the line last obtained. Having produced by rubbing, a plane, that is to say, a surface having the same form at *all points* and on *both* sides, experience furnishes additional results. Placing two such planes one on the other, it will be learned that the plane is *displaceable* into itself, and *rotatable* within itself, just as a straight line is. A thread stretched between any two points in the plane falls entirely within the plane. A piece of cloth drawn tight across any bounded portion of a plane coincides with it. Hence the plane represents the minimum of surface within its boundaries. If the plane be laid on two sharp points, it can still be rotated around the straight line joining the points, but any third point outside of this straight line fixes the plane, that is, determines it completely.

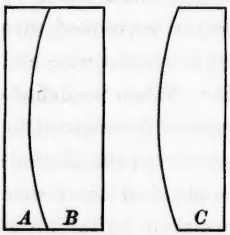

Fig. 7.

In the letter to Vitale Giordano, above referred to, Leibnitz makes the frankest use of this experience with corporeal objects, when he defines a plane as a surface which divides an unbounded solid into two congruent parts, and a straight line as a line which divides an unbounded plane into two congruent parts.[1]

If attention be directed to the symmetry of the plane with respect to itself, and two points be assumed, one on each side of it, each symmetrical to the other, it will be found that every point in

[1] The passage reads literally: "Et difficulter absolvi poterit demonstratio, nisi quis assumat notionem rectæ, qualis est qua ego uti soleo, quod corpore aliquo duobus punctis immotis revoluto locus omniom punctorum quiescentium sit recta, vel saltem quod recta sit linea secans planum interminatum in duas partes congruas; et planum sit superficies secans solidum interminatum in duas partes congruas." For similar definitions, see, for example, Halsted's *Elements of Geometry*, 6th edition. New York, 1895, p. 9.—*T. J. McC.*

the plane is equidistant from these two points, and Leibnitz's definition of the plane is reached.[1] The uniformity and symmetry of the straight line and the plane are consequences of their being *absolute* minima of length and area respectively. For the boundaries given the minimum must exist, no other collateral condition being involved. The minimum is unique, *single in its kind;* hence the *symmetry* with respect to the bounding points. Owing to the *absoluteness* of the minimum, every portion, however small, again exhibits the same minimal property; hence the uniformity.

Empirical truths organically connected may make their appearance independently of one another, and doubtless were so discovered long before the fact of their connection was known. But this does not preclude their being afterwards recognised as involved in, and *determined* by, one another, as being *deducible* from one another. For example, supposing we are acquainted with the symmetry and uniformity of the straight line and the plane, we easily deduce that the intersection of two planes is a *straight line*, that any two points of the plane can be joined by a straight line lying wholly within the plane, etc. The fact that only a *minimum* of inconspicuous and unobtrusive experiences is requisite for such deductions should not lure us into the error of regarding this minimum as wholly superfluous, and of believing that visualisation and reasoning are alone sufficient for the construction of geometry.

Like the concrete visual images of the straight line and the plane, so also our visualisations of the circle, the sphere, the cylinder, etc., are enriched by metrical experiences, and in this manner first rendered amenable to fruitful geometrical treatment. The same economic impulse that prompts our children to retain only the *typical* features in their concepts and drawings, leads us also to the *schematisation* and conceptual *idealisation* of the images derived from our experience. Although we never come across in nature a perfect straight line or an exact circle, in our thinking we nevertheless designedly abstract from the deviations which thus

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[1] Leibnitz, *in re* "geometrical characteristic," letter to Huygens, Sept. 8, 1679 (Gerhardt, *loc. cit.*, *erste Abth.*, *Bd. II.*, *S.* 23).

occur. Geometry, therefore, is concerned with *ideal objects* produced by schematisation of *experiential objects*. I have remarked elsewhere that it is wrong in elementary geometrical instruction to cultivate predominantly the logical side of the subject, and to neglect to throw open to young students the wells of knowledge contained in experience. It is gratifying to note that the Americans, who are less dominated than we by tradition, have recently broken with this system and are introducing a sort of experimental geometry as introductory to systematic geometric instruction.[1]

III.

No sharp line can be drawn between the instinctive, the technical, and the scientific acquisition of geometric notions. Generally speaking, we may perhaps say that with the division of labor in the industrial and economic fields, with increasing employment with specific objects, the instinctive acquisition of knowledge falls into the background, and the technical begins. Finally, *when measurement becomes an aim and profession in itself*, the *connection* obtaining between the various operations of measuring acquires a powerful *economic* interest, and we reach the period of the scientific development of geometry, to which we now proceed.

The knowledge that the measures of geometry depend on one another, was reached in divers ways. After surfaces came to be measured by surfaces, certain other progress was almost inevitable. In a parallelogrammatic field permitting of division into equal partial parallelogrammatic fields so that n rows of partial fields each containing m fields lay alongside one another, the counting of these fields was unnecessary. By multiplying together the numbers measuring the sides, the area of the field was found to be equal to mn such fields, and the area of each of the two triangles formed by drawing the diagonal was readily discovered to be equal

[1] W. T. Campbell, *Observational Geometry*, New York, 1899; W. W. Spear, *Advanced Arithmetic*, Boston, 1899. [See also Hanus, *Geometry in the Grammar School*, Boston, 1898, and the recommendations of the Harvard Catalogue for 1901–1902, p. 307.—*Tr.*]

to $\frac{mn}{2}$ such fields. This was the first and simplest application of arithmetic to geometry. Coincidently, the dependence of measures of area on other measures, linear and angular, was discovered. The area of a rectangle was found to be larger than that of an oblique parallelogram having sides of the same length; the area, consequently, depended not only on the length of the sides, but also on the angles. On the other hand, a rectangle constructed of strips of wood running parallel to the base, can, as is easily seen, be converted by displacement into any parallelogram of the same height and base without altering its area. Quadrilaterals having their sides given are still undetermined in their angles, as every carpenter knows. He adds diagonals, and converts his quadrilateral into triangles, which, the sides being given, are rigid, that is to say, are unalterable as to their angles also. With the perception that measures were dependent on one another, the real problem of geometry was introduced. Steiner has aptly and justly entitled his principal work "Systematic Development of the Dependence of Geometrical Figures on One Another."[1] In Snell's original unappreciated treatise on Elementary Geometry, the problem in question is made obvious even to the beginner.[2]

A plane physical triangle is constructed of wires. If one of the sides be rotated around a vertex, so as to increase the interior angle at that point, the side moved will be seen to change its position and the side opposite to grow *larger* with the angle. *New* pieces of wire besides those before present will be required to complete the last-mentioned side. This and other similar experiments can be repeated in thought, but the mental experiment is never anything more than a copy of the physical experiment. The mental experiment would be impossible if physical experience had not antecedently led us to a knowledge of *spatially unalterable physical bodies*,[3]—to the concept of measure. By experiences of this char-

[1] J. Steiner, *Systematische Entwicklung der Abhängigkeit der geometrischen Gestalten von einander.*

[2] Snell, *Lehrbuch der Geometrie*, Leipsic, 1869.

[3] The entire construction of the Euclidean geometry shows traces of this foundation. It is still more conspicuous in the "geometric characteristic" of Leibnitz already mentioned. We shall revert to this topic later.

acter, we are conducted to the truth that of the six metrical magnitudes discoverable in a triangle (three sides and three angles) three, including at least *one* side, suffice to determine the triangle. If *one* angle only be given among the parts determining the triangle, the angle in question must be either the angle included by the given sides, or that which is opposite to the greater side,—at least if the determination is to be *unique*. Having reached the perception that a triangle is determined by three sides and that its form is independent of its position, it follows that in an equilateral triangle all three angles and in an isosceles triangle the two angles opposite the equal sides, must be equal, in whatever manner the angles and sides may depend on one another. This is logically certain. But the empirical foundation on which it rests is for that reason not a whit more superfluous than it is in the analogous cases of physics.

The mode in which the sides and angles depend on one another is first recognised, naturally, in special instances. In computing the areas of rectangles and of the triangles formed by their diagonals, the fact must have been noticed that a rectangle having sides 3 and 4 units in length gives a right-angled triangle having sides, 3, 4, and 5 units in length. Rectangularity was thus shown to be connected with a definite, rational ratio between the sides. The knowledge of this truth was employed to stake off right angles, by means of three connected ropes respectively 3, 4, and 5 units in length.[1] The equation $3^2+4^2=5^2$, the analogue of which was proved to be valid for all right-angled triangles having sides of length a, b, c (the general formula being $a^2+b^2=c^2$), now riveted the attention. It is well known how profoundly this relation enters into metrical geometry, and how all indirect measurements of distance may be traced back to it. We shall endeavor to disclose the foundation of this relation.

It is to be remarked first that neither the Greek geometrical nor the Hindu arithmetical deductions of the so-called *Pythagorean Theorem* could avoid the consideration of areas. One essential

[1] Cantor, *Geschichte der Mathematik*, Leipsic, 1880. I., pp. 53, 56.

point on which all the deductions rest and which appears more or less distinctly in different forms in all of them, is the following: If a triangle, a, b, c (Fig. 8) be slid along a short distance in its own

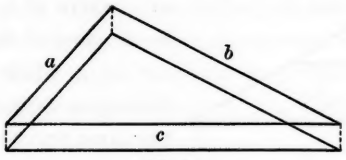

Fig. 8.

plane, it is assumed that the space which it leaves behind is made up for, or compensated for, by the new space on which it enters. That is to say, the area swept out by *two* of the sides during the displacement is equal to the area swept out by the *third* side. The basis of this conception is the assumption of the *conservation of the area* of the triangle. If we consider a surface as a body of very minute but unvarying thickness of third dimension (which for that reason is uninfluential in the present connection), we shall again have the *conservation of the volume of bodies* as our fundamental assumption. The same conception may be applied to the translation of a tetrahedron, but it does not lead in this instance to new points of view. Conservation of volume is a property which rigid and liquid bodies possess in common and was idealised by the old physics as *impenetrability*. In the case of rigid bodies, we have the additional attribute that the distances between all the parts are preserved, while in the case of liquids, the properties of rigid bodies exist only for the smallest time and space elements.

If an oblique-angled triangle having the sides a, b, and c be displaced in the direction of the side b, only a and c will, by the principle above stated, describe equivalent parallelograms, which are alike in an equal pair of parallel sides on the same parallels. If a make with b a right angle, and the triangle be displaced at right angles to c, the distance c, the side c will describe the square c^2, while the two other sides will describe parallelograms the combined areas of which are equal to the area of the square. The two parallelograms are, by the observation which just precedes, equivalent respectively to a^2 and b^2,—and with this the Pythagorean the-

orem is reached. The same result may also be attained (Fig. 9) by first sliding the triangle a distance a at right angles to a, and then a distance b at right angles to b, where $a^2 + b^2$ will be equal to the sum of the surfaces swept out by c, which is obviously c^2. Taking an oblique-angled triangle, the same procedure just as easily and obviously gives the more general proposition, $c^2 = a^2 + b^2 - 2ab\cos\gamma$.

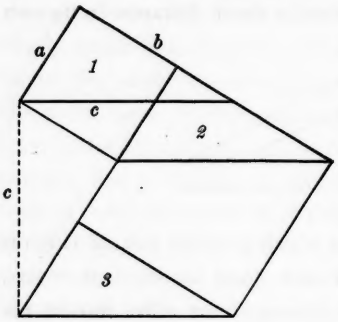

Fig. 9.

The dependence of the third side of the triangle on the two other sides is accordingly determined by the area of the enclosed triangle; or, in our conception, by a condition involving *volume*. It will also be directly seen that the equations in question express relations of area. It is true that the angle included between two of the sides may also be regarded as determinative of the third side, in which case the equations will apparently assume an entirely different form. Let us look a little more closely at these different measures. If the extremities of two straight lines of lengths a and b meet in a point, the length of the line c joining their free extremities will be included between definite limits. We shall have $c \gtreqless a + b$, and $c \lesseqgtr a - b$. Visualisation alone cannot inform us of this fact; we can learn it only from *experimenting in thought*,—a procedure which reposes on physical experience and reproduces it. This will be seen by holding a fast, for example, and turning b, first, until it forms the prolongation of a, and, secondly, until it coincides with a. A straight line is primarily a unique concrete image characterised by physiological properties,—an image which we have obtained from a *physical* body of a definite specific character, which in the form of a string or wire of indefinitely small but constant thickness interposes a *minimum of volume* between the positions of its extremities,—which can be accomplished only in *one uniquely-determined* manner. If several straight lines pass through a point, we distinguish between them *physiologically* by their direc-

tions. But in *abstract space* obtained by metrical experiences with physical objects, differences of direction do not exist. A straight line passing through a point can be completely determined in abstract space only by assigning a second *physical* point on it. To define a straight line as a line which is constant in direction, or an angle as a *difference between directions*, or parallel straight lines as straight lines having the *same* direction, is to define these concepts *physiologically*.

Different methods are at our disposal when we come to characterise or determine *geometrically* angles which are *visually* given. An angle is determined when the distance is assigned between any two fixed points lying each on a separate side of the angle outside the point of intersection. To render the definition uniform, points situated at the same fixed and invariable distance from the vertex might be chosen. The inconvenience that then equimultiples of a given angle placed alongside one another in the same plane with their vertices coincident, would not be measured by the same equimultiples of the distance between those points, is the reason that this method of determining angles was not introduced into elementary geometry.[1] A simpler measure, a simpler characterisation of an angle, is obtained by taking the aliquot part of the *circumference* or the *area* of a circle which the angle intercepts when laid in the plane of the circle with its vertex at the center. The convention here involved is more convenient.[2]

In employing an arc of a circle to determine an angle, we are again merely measuring a volume,—viz., the volume occupied by a body of simple definite form introduced between two points on the arms of the angle equidistant from the vertex. But a circle can be characterised by simple rectilinear distances. It is a matter of perspicuity, immediacy, and of the facility and convenience resulting therefrom, that two measures, viz., the rectilinear measure of length and the angular measure, are principally employed as

[1] A closely allied principle of measurement is, however, applied in trigonometry.

[2] So also the superficial portion of a sphere intercepted by the including planes is used as the measure of a solid angle.

fundamental measures, and the others derived from them. It is in no sense necessary. For example (Fig. 10), it is possible without a special angular measure to determine the straight line that cuts another straight line at right angles by making all its points equidistant from two points in the first straight line lying at equal distances from the point of intersection. The bisector of an angle can be determined in a quite similar manner, and by continued bisection an angular unit can be derived of any smallness we wish. A straight line *parallel* to another straight line can be defined as one, all of whose points can be translated by congruent curved or *straight* paths into points of the first straight line.[1] It is quite possible to start with the straight length *alone* as our fundamental measure. Let a fixed physical point a be given. Another point, m, has the distance r_a from the first point. Then this last point can still lie in any part of the spherical surface described about a with radius r_a. If we know still a second fixed point b, from which m is removed by the distance r_b, the triangle abm will be rigid, determined; but m can still revolve round in the circle described by the rotation of the triangle around the axis ab. If now the point m be held fast in any position, then also the whole rigid body to which the three points in question, a, b, m, belong will be fixed.

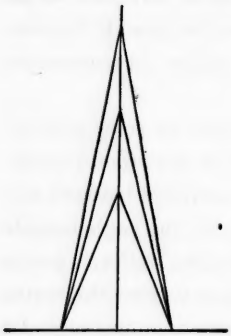

Fig. 10.

A point m is spatially determined, accordingly, by the distances r_a, r_b, r_c from at least three fixed points in space, a, b, c. But this determination is still not unique, for the pyramid with the edges r_a, r_b, r_c, in the vertex of which m lies, can be constructed as well on the one as on the other side of the plane a, b, c. If we were to fix the side, say by a special sign, we should be resorting to a *physiological* determination, for *geometrically* the two sides of the plane are not different. If the point m is to be uniquely deter-

[1] If this form had been adopted, the doubts as to the Euclidean theorem of parallels would probably have risen much later.

mined, its distance, r_d, from a fourth point, d, lying *outside* the plane abc, must be given in addition. Another point, m', is determined with like completeness by four distances, r'_a, r'_b, r'_c, r'_d. Hence, the distance of m from m' is also given by this determination. And the same holds true of any number of other points as severally determined by four distances. Between four points $\frac{4(4-1)}{1\cdot 2} = 6$ distances are conceivable, and precisely this number must be given to determine the form of the point complex. For $4+s=n$ points, $6+4s$ or $4n-10$ distances are needed for the determination, while a still larger number, viz., $n\left(\frac{n-1}{1\cdot 2}\right)$ distances exist, so that the excess of the distances is also coincidently determined.

If we start from *three* points and prescribe that the distances of all points to be further determined shall hold for one side only of the plane determined by the three points, then $3n-6$ distances will suffice to determine the form, magnitude, and position of a system of n points with respect to the three initial points. But if there be no condition as to the side of the plane to be taken,—a condition which involves sensuous and physiological, but not abstract metrical characteristics,—the system of points, instead of the intended form and position, may assume that symmetrical to the first, or be combined of the points of both. *Symmetric* geometrical figures are, owing to our symmetric *physiological organisation*, very easily taken for the same, whereas *metrically* and *physically* they are entirely different. A screw with its spiral winding to the right and one with its spiral winding to the left, two bodies rotating in contrary directions, etc., appear very much alike to the eye. But we are for this reason not permitted to regard them as geometrically or physically equivalent. Attention to this fact would avert many paradoxical questions. Think only of the trouble that such problems gave Kant! Sensuous physiological attributes are determined by relationship to *our body*, to a corporeal system of *specific* constitution; while metrical attributes are determined by relations to the world of physical bodies *at large*. The latter can be ascertained only by experiments of coincidence,—by measurements.

As we see, every geometrical measurement is at bottom reducible to measurements of *volumes*, to the *numeration of bodies*. Measurements of lengths, like measurements of areas, repose on the comparison of the volumes of very thin strings, sticks, and leaves of constant thickness. This is not at variance with the fact that measures of area may be *arithmetically* derived from measures of length, or solid measures from measures of length alone, or from these in combination with measures of area. This is merely proof that *different* measures of volume are dependent on one another. To ascertain the forms of this interdependence is the *fundamental object of geometry*, as it is the province of arithmetic to ascertain the manner in which the various numerical operations, or ordinating activities of the mind, are connected together.

It is extremely probable that the experiences of the visual sense were the reason for the *rapidity* with which geometry developed. But our great familiarity with the properties of rays of light gained from the present advanced state of optical technique, should not mislead us into regarding our *experiential knowledge of rays of light* as the principal foundation of geometry. Rays of light in dust or smoke-laden air furnish admirable *visualisations* of straight lines. But we can derive the *metrical properties* of straight lines from rays of light just as little as we can derive them from *imaged* straight lines. For this purpose experiences with *physical* objects are absolutely necessary. The *rope-stretching* of the practical geometers is certainly older than the use of the theodolite. But once knowing the physical straight line, the ray of light furnishes a very distinct and handy means of reaching new points of view. A blind man could scarcely have invented modern synthetic geometry. But the oldest and the most powerful of the experiences lying at the basis of geometry are just as accessible to the blind man, through his sense of touch, as they are to the person who can see. Both are acquainted with the spatial *permanency of bodies* despite their *mobility;* both acquire a conception of *volume* by *taking hold* of objects. The creator of primitive geometry disregards, first instinctively and then intentionally and consciously, those physical properties that are unessential for his operations and that for the moment do not

concern him. In this manner, and by gradual growth, the idealised concepts of geometry arise on the basis of experience.

IV.

Our geometrical knowledge is thus derived from various sources. We are *physiologically* acquainted, from direct visual and tactual contact, with many and various spatial forms. With these are associated physical (*metrical*) experiences (involving comparison of the space-sensations evoked by different bodies under the same circumstances), which experiences are in their turn also but the expressions of other relations obtaining between sensations. These diverse orders of experience are so intimately interwoven with one another that they can be separated only by the most thoroughgoing scrutiny and analysis. Hence originate the widely divergent views concerning geometry. Here it is based on pure visualisation (*Anschauung*), there on physical experience, according as the one or the other factor is overrated or disregarded. But both factors entered into the development of geometry and are still active in it to-day; for, as we have seen, geometry by no means exclusively employs purely metrical concepts.

If we were to ask an unbiassed, candid person under what form he pictured space, referred, for example, to the Cartesian system of co-ordinates, he would doubtless say: I have the image of a system of rigid (form-fixed), transparent, penetrable, contiguous cubes, having their bounding surfaces marked only by nebulous visual and tactual percepts,—a species of phantom cubes. Over and through these phantom constructs the real bodies or their phantom counterparts move, conserving their spatial permanency (as above defined), whether we are pursuing practical or theoretical geometry, or phoronomy. Gauss's famous investigation of curved surfaces, for instance, is really concerned with the application of infinitely thin laminate and hence flexible bodies to one another. That diverse orders of experience have co-operated in the formation of the fundamental conceptions under consideration, cannot be gainsaid.

Yet, varied as the special experiences are from which geometry has sprung, they may be reduced to a minimum of facts: Movable bodies exist having definite spatial permanency,—viz., rigid bodies exist. But the movability is characterised as follows: we draw from a point three lines not all in the same plane but otherwise undetermined. By three movements parallel to these straight lines any point can be reached from any other. Hence, three measurements or dimensions, physiologically and metrically characterised as the simplest, are sufficient for all spatial determinations. These are the fundamental facts.[1]

The physical metrical experiences, like all experiences forming the basis of experimental sciences, are conceptualised,—idealised. The *need* of representing the facts by simple perspicuous concepts under easy logical control, is the reason for this. Absolutely rigid, spatially invariable bodies, perfect straight lines and planes, no more exist than a perfect gas or a perfect liquid. Nevertheless, we work preferably and also more readily with these concepts than with others that conform more closely to the properties of the objects, deferring the consideration of the deviations. *Theoretical* geometry does not even need to consider these deviations, inasmuch as it assumes objects that fulfil the requirements of the theory absolutely, just as theoretical physics does. But in the case of *practical* geometry, where we are concerned with actual objects, we are obliged, as in practical physics, to consider the deviations from the theoretical assumptions. But geometry has the additional advantage that every deviation of its objects from the assumptions of the theory *which may still be detected* can be *removed*; whereas physics for obvious reasons cannot construct more perfect gases than actually exist in nature. For, in the latter case, we are concerned not with a *single* arbitrarily constructible spatial property alone, but with a relation, occurring in nature and independent of our will, between pressure, volume, and temperature.

The choice of the concepts is suggested by the facts; yet, see-

[1] The historical development of this conception will be considered in another place.

ing that this choice is the outcome of our *voluntary* reproduction of the facts in thought, some free scope is left in the matter. The importance of the concepts is estimated by their range of application. This is why the concepts of the straight line and the plane are placed in the foreground, for every geometrical object can be split up with sufficient approximateness into elements bounded by planes and straight lines. The particular properties of the straight line, plane, etc., which we decide to emphasise, are matters of our own free choice, and this truth has found expression in the various definitions that have been given of the same concept.[1]

The fundamental truths of geometry have thus, unquestionably, been derived from physical experience, if only for the reason that our visualisations and sensations of space are absolutely inaccessible to measurement and cannot possibly be made the subject of metrical experience. But it is no less indubitable that when the relations connecting our visualisations of space with the simplest metrical experiences have been made familiar, then geometrical facts can be reproduced with great facility and certainty in the imagination alone,—that is by purely *mental experiment*. The very fact that a continuous change in our space-sensation corresponds to a continuous metrical change in physical bodies, enables us to ascertain by imagination alone the particular metrical elements that depend on one another. Now, if such metrical elements are observed to enter different constructions having different positions in precisely the same manner, then the metrical results will be regarded as *equal*. The case of the isosceles and equilateral triangles, above mentioned, may serve as an example. The *geometric* mental experiment has advantage over the physical, only in the respect that it can be performed with far simpler experiences and with such as have been more easily and almost unconsciously acquired.

Our sensuous imagings and visualisations of space are *qualitative*, not quantitative nor metrical. We derive from them coincidences and differences of extension, but never real magnitudes.

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[1] Compare, for example, the definitions of the straight line given by Euclid and by Archimedes.

Conceive, for example, Fig. 11, a coin rolling clockwise down and around the rim of another fixed coin of the same size, without sliding. Be our imagination as vivid as it will, it is impossible by a pure feat of reproductive imagery alone, to determine here the angle described in a full revolution. But if it be considered that at the beginning of the motion the radii *a*, *a'* lie in one straight line, but that after a *quarter* revolution the radii *b*, *b'* lie in a straight line, it will be seen at once that the radius *a'* now points vertically upwards and has consequently performed *half* a revolution. The *measure* of the revolution is obtained from metrical concepts, which fixate idealised experiences on definite physical objects, but the *direction* of the revolution is retained in the *sensuous* imagination. The metrical concepts simply determine that in equal circles equal angles are subtended by equal arcs, that the radii to the point of contact lie in a straight line, etc.

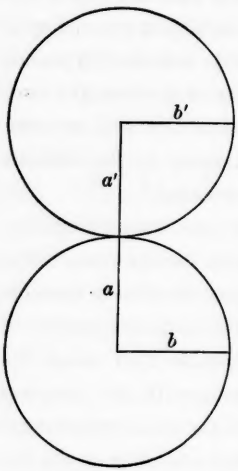

Fig. 11.

If I picture to myself a triangle with one of its angles increasing, I shall also see the side opposite the angle increasing. The impression thus arises that the interdependence in question follows *a priori* from a feat of imagination alone. But the imagination has here merely reproduced a fact of experience. Measure of angle and measure of side are *two physical* concepts applicable to *the same* fact,—concepts that have grown so familiar to us that they have come to be regarded as merely *two* different attributes of the *same* imaged group of facts, and hence appear as linked together of sheer necessity. Yet we should never have acquired these concepts without physical experience. Compare page 496.

The combined action of the sensuous imagination with idealised concepts derived from experience is apparent in every geometrical deduction. Let us consider, for example, the simple theorem that the perpendicular bisectors of the sides of a triangle *ABC* meet in

a common point. Experiment and imagination both doubtless led to the theorem. But the more carefully the construction is executed, the more one becomes convinced that the third perpendicular does not pass exactly through the point of intersection of the first two, and that in any actual construction, therefore, three points of intersection will be found closely adjacent to one another. For in reality neither perfect straight lines nor perfect perpendiculars can be drawn; nor can the latter be erected exactly at the midpoints; and so on. *Only* on the assumption of such *ideal* conditions does the perpendicular bisector of AB contain all points equally distant from A and B, and the perpendicular bisector of BC all points equidistant from B and C. From which it follows that the point of intersection of the two is equidistant from A, B, and C, and by reason of its equidistance from A and C is also a point of the *third* perpendicular bisector, of AC. The theorem asserts therefore that the more accurately the assumptions are fulfilled the more nearly will the three points of intersection coincide.

The importance of the combined action of the sensuous imagination [viz., of the *Anschauung* or intuition so called] and of concepts, will doubtless have been rendered clear by these examples. Kant says: "Thoughts without contents are empty, intuitions without concepts are blind."[1] Possibly we might more appropriately say: "Concepts without intuitions are blind, intuitions without concepts are lame." For it would appear to be not so absolutely correct to call intuitions [viz., sensuous images] blind and concepts empty. When Kant further says that "there is in every branch of natural knowledge only so much science as there is mathematics contained in it,"[2] one might possibly also assert of all sciences *including* mathematics "that they are only in so far sciences as they operate with concepts." For our logical mastery extends only to those concepts of which we have ourselves determined the contents.

The two facts that bodies are rigid and movable would be suf-

[1] *Kritik der reinen Vernunft*, 1787, p. 75. Max Müller's translation, 2nd ed., 1896, p. 41.

[2] *Metaphysische Anfangsgründe der Naturwissenschaft. Vorwort.*

ficient for an understanding of any geometrical fact, no matter how complicated,—sufficient, that is to say, to derive it from the two facts mentioned. But geometry is obliged, both in its own interests and in its rôle as an auxiliary science, or in the pursuit of practical ends, to answer questions that *recur repeatedly in the same form.* Now it would be uneconomical, in such a contingency, to begin each time with the most elementary facts and to go to the bottom of each new case that presented itself. It is preferable, rather, to select a certain few simple, familiar, and indubitable theorems, in our choice of which caprice is by no means excluded,[1] and to formulate from these, *once for all,* for application to practical ends, general propositions answering the questions that most frequently recur. From this point of view we understand at once the *form* geometry has assumed,—the emphasis, for example, that it lays upon its propositions concerning triangles. For the designated purpose, it is desirable to collect the most general possible propositions, having the widest range of application. From history we know that propositions of this character have been obtained by comprehending various special cases of knowledge under single general cases. We are forced even to-day to resort to this procedure when we treat the relationship of two geometrical figures, or when the different special cases of form and position compel us to modify our modes of deduction. We may cite as the most familiar instance of this in elementary geometry, the mode of deducing the relation obtaining between angles at the centre and angles at the circumference.

Kroman[2] has put the question, Why do we regard a demonstration made with a special figure (a special triangle) as universally valid for all figures? and finds his answer in the supposition that we are able by rapid variations to impart all possible forms to the figure in thought and so convince ourselves of the admissibility of the same mode of inference in all special cases. History and introspection declare this idea to be in all essential respects correct.

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[1] Zindler, *Zur Theorie der mathematischen Erkenntniss. Sitzungsberichte der Wiener Akademie. Philos-histor. Abth.* Bd. 118. 1889.

[2] *Unsere Naturerkenntniss.* Copenhagen, 1883, pp. 74 et seq.

But we may not assume, with Kroman, that in each special case every individual student of geometry acquires this complete synoptic view "with the rapidity of lightning," and attains forthwith to the lucidity and intensity of geometric conviction in question. Frequently the required operation is absolutely impracticable, and errors prove that in other cases it was actually not performed but that the inquirer rested content with a conjecture based on analogy.[1] But that which the individual does not or cannot achieve in a jiffy, he may achieve in the course of his life. Whole generations labor on the verification of geometry. And the conviction of its certitude is unquestionably strengthened by their collective exertions. I once knew an otherwise excellent teacher who compelled his students to perform all their demonstrations with *incorrect* figures, on the theory that it was the *logical* connection of the concepts, not the figure, that was essential. But the experiences imbedded in the concepts cleave to our sensuous images. Only the actually visualised or imaged figure can tell us what particular concepts are to be employed in a given case. The method of this teacher is admirably adapted for rendering palpable the degree to which logical operations share in reaching truth. But to employ it habitually is to miss utterly the truth that concepts draw their ultimate power from sensuous sources.

E. MACH.

VIENNA, October, 1901.

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[1] Hoelder, *Anschauung und Denken in der Geometrie*, p. 12.

RELATIONS BETWEEN EXPERIMENTAL PHYSICS AND MATHEMATICAL PHYSICS.[1]

RÔLE OF EXPERIMENT AND OF GENERALISATION.

EXPERIMENT is the sole source of truth: this alone can teach us something new; this alone can give us certainty. These two points no one may question.

But if experiment is all, what place is there for mathematical physics? What has experimental physics to do with such an auxiliary which seems useless and even perhaps dangerous? Nevertheless mathematical physics exists, and has been of undeniable service; this fact needs explanation.

Observation is not sufficient; use must be made of our observations, and for that generalisation is necessary. This has always been done; but man profiting from past errors, has observed more and more and generalised less and less. Each century has scoffed at the preceding, accusing it of generalising too boldly and too naïvely. Descartes commiserated the Ionians; Descartes in his turn makes us smile; without doubt our sons will some day laugh at us. Is there no way to get at the gist of the matter at once and escape the raillery that we foresee? May we not be content with experiment alone?

No, that is impossible and would be misunderstanding completely the true character of science. The savant must work with

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[1] Written in 1900 and delivered before the International Congress of Physics, in Paris. Translated by George K. Burgess, Docteur de l'Université de Paris, Instructor in Physics, University of California.

method; science is made of facts as a house of stones; but an accumulation of facts is no more a science than a pile of stones a house. Above all the scientist must foresee. Carlyle says: "The fact alone matters; John Lackland passed by here, that is what is admirable, here is a reality for the which I would give all the theories in the world." Carlyle was a compatriot of Bacon; like him he desired to proclaim the cult *for the God of Things as they are*, but Bacon would not have said that. It is the language of the historian. Most likely the physicist would have said: "John Lackland passed by here; never mind, for he will not pass this way again."

We all know that there are good experiments and poor ones. The latter accumulate in vain; whether there are a hundred or a thousand, a single piece of work by a real master, a Pasteur for instance, suffices to make them fall into obscurity. This, Bacon would have well understood; is it not he who invented the expression *experimentum crucis?* But Carlyle would not have understood it. A fact is a fact; a student has read a number on his thermometer, taking no precautions; no matter, he has read it, and if it is the fact only that counts, this is a reality of the same degree as the wanderings of John Lackland. What then is a good experiment? It is one which teaches us something more than an isolated fact; it aids us to predict, and enables us to generalise.

Without generalisation, prediction is impossible. The circumstances under which one has operated will never be simultaneously reproduced. The observed fact can never be realised again; the only thing that can be affirmed, is that under analogous circumstances, an analogous fact will be produced. In order to predict it is necessary to invoke analogy, that is, to generalise.

However timid one may be, it is necessary to interpolate; experiment gives us only a certain number of isolated points, which must be united by a continuous line; this is a true generalisation. But one does more, the curve so traced will pass between and near these points; but not through them. So that one is not limited to the generalisation of the experiment, he corrects it; and the physicist who would abstain from these corrections and content himself

solely with experiment would be forced to announce the most extraordinary laws. The detached facts are not enough; that is why we must have Science ordered, or better, organised.

It is often said that we must experiment with no preconceived idea. That is not possible; not only would this render sterile every experiment, but even if we wanted to do so, it could not be done. Every one has within him his idea of the world, which cannot be so easily put aside. For example, we have to make use of language, which is made up necessarily of preconceived ideas. Such ideas unconsciously held are the most dangerous of all.

Shall we say that if we cause to intervene others of which we have full consciousness, we shall but aggravate the evil? I do not think so; I believe rather that they will act as mutual counterweights, I was going to say antidotes, that in general will accord poorly and even conflict with each other forcing us to look at things from different aspects. This is enough to free us: he who can choose his master is no longer a slave.

Thus, thanks to generalisation, each observed fact enables us to predict a great number of others; but we must not forget that the first alone is certain and the others merely probable. However well founded a prediction may seem, we are never *absolutely* sure that experiment will not prove it false, if we undertake to verify it. But the probability of truth is often so great that practically we may be content with it. Better is it to predict without certainty than never to have predicted at all.

We should never disdain to make a verification when the occasion presents itself. But every experiment is long and difficult, the workers are few, and the quantity of facts that we need to predict is immense; beside this mass, the number of direct verifications that we can make will ever be a negligible quantity. Of this little that we may directly reach, we must select the better part; it is necessary that each experiment should allow the greatest possible number of predictions having the highest degree of probability. The problem is, so to speak, to increase the efficiency of the scientific machine.

Allow me to compare science to a library which must increase

indefinitely; the librarian has at his disposal for purchases but limited funds, which must not be wasted. It is experimental physics that is charged with the buying; she alone can enrich the library. As for mathematical physics, her mission is to make the catalogue; if this is well made, the library will not be richer; but it may aid the reader to make use of these riches. Also by showing the librarian the gaps in his collections, it will aid him to make judicious use of his funds; which is the more important as the funds are quite inadequate.

Such is the rôle of mathematical physics; she should direct generalisation so as to augment what I have just called the efficiency of Science. By what means she accomplishes this, and how she may do so without danger, that is what we shall examine.

THE UNITY OF NATURE.

We observe in the first place that every generalisation supposes in a certain measure the belief in the unity and in the simplicity of nature. In the case of unity there can be no difficulty. If the different parts of the universe were not as the organs of the same body, they would not react on each other, they would ignore each other mutually; and we in particular could know but one part. Consequently we have not to ask ourselves if nature is one, but how she is one.

As to the second point, all is not so clear. It is not certain that nature is simple. Can we without danger act as if she were so?

There was a time when the simplicity of Mariotte's law was an argument presented in favor of its exactness, when Fresnel himself, after having said, in conversation with Laplace, that nature did not occupy herself with analytical difficulties, was obliged to explain his words, so as not to offend the current public opinion. To-day ideas have changed much; nevertheless those who do not believe that natural laws must be simple, are still often obliged to act as if they so believed. They cannot separate themselves entirely from this appearance without rendering impossible all generalisation and consequently all science.

It is clear that any fact soever may be generalised in an infinite number of ways, and one must choose among them. The choice will be determined by considerations of simplicity. Take the case of interpolation. We draw a line as regularly as possible among the points given by observation. Why do we avoid the discordant points, the too sharp inflections? Why do we not describe a curve having the most capricious zigzags? It is because we know beforehand, or we think we know, that the law to be expressed cannot be as complicated as that. Jupiter's mass may be deduced either from the movements of his satellites, from the perturbations of the greater planets, or from those of the lesser planets. If the averages of the determinations obtained by these methods are taken, we find three numbers nearly but not quite identical. This result might be interpreted by supposing that the gravitation constant is not the same in the three cases; the observations would be certainly much better represented. Why do we reject this interpretation? Not because it is absurd but that it is uselessly complicated. It will not be accepted until it is forced upon us, and that day is not yet.

To resume, every law is reputed simple until proved otherwise.

This custom is forced upon physicists by the reasons that I have indicated; but how justify it in the presence of discoveries that daily show us new details richer and more complex? How reconcile it even with the unity of nature? For if all things are interdependent, the relations in which so many different objects intermingle cannot be simple.

If we study the history of science, we see produced two phenomena that are, so to speak, the inverse of each other: on the one hand there is a simplicity hidden under complex appearances, on the other hand an apparent simplicity conceals extremely complex realities.

What is more complicated than the troubled movements of the planets, what more simple than Newton's law? There, nature playing, as Fresnel said, with the analytical difficulties, employs but simple means and engenders by their combination I know not

what tangled snarl. Here is a case of hidden simplicity,—one which must be unravelled.

Examples of the other kind abound. In the kinetic theory of gases, we consider the molecules animated with great velocities, whose paths, deformed by incessant impacts, have the most capricious shapes, and cross space in all directions. The observable result is the simple law of Mariotte; each individual fact was complicated; the law of great numbers has re-established simplicity in the mean. Here the simplicity is only apparent, and the coarseness of our senses alone prevents us from perceiving the complexity.

Many phenomena obey a law of proportionality; but why? Because in these phenomena there is something which is very small. The simple law observed is then but a translation of this general analytical rule, according to which the infinitely small increment of a function is proportional to the increment of the variable. Since in reality the increments are not infinitely small, but very small, the proportionality law is but approximate and the simplicity is but apparent. What I have said applies to the law of the superposition of small movements, whose use is so fruitful and which is the basis of optics.

And Newton's law itself? Its simplicity, so long hidden, is perhaps only apparent. Who knows if it is not due to some complicated mechanism, to the impact of some subtle matter animated with irregular movements, and if it has not become simple merely by the play of averages and of large numbers? In any case it is difficult not to suppose that the true law contains supplementary terms, which may become sensible at small distances. If in astronomy they are negligible in comparison with Newton's expression, and if the law becomes thus simplified, this is merely on account of the enormity of the celestial distances.

Without doubt, if our means of investigation became more and more penetrating, we should discover the simple within the complex, then the complex from the simple, then again the simple within the complex, and so on, without being able to predict which would be the last term. It is necessary to stop somewhere, and

for science to be possible, we must stop where we have found simplicity. That is the only foundation upon which we can construct the edifice of our generalisations. But, the simplicity being only apparent, will this foundation be solid enough? That is what is to be studied.

For this, let us see what rôle our generalisations play in the belief in simplicity. We have verified a simple law in a considerable number of particular cases; we refuse to admit that this occurrence, so often repeated, is a result of mere chance, and we conclude that the law must be true in the general case.

Kepler finds that the positions of a planet observed by Tycho are all on the same ellipse. He has not for a single instant the thought that, by a singular chance, Tycho never regarded the heavens but at the moment when the true trajectory of the planet happened to cut this ellipse.

What does it matter then if the simplicity is real, or if it conceals a complex truth? Whether it be due to the influence of large numbers which level individual differences, or to the greatness or smallness of certain quantities which allow of neglecting certain terms, in no case is it due to chance. This simplicity, real or apparent, has always a cause. We may then reason in the same way at all times, and if a simple law has been observed in several particular cases, we may legitimately suppose that it will still be true in analogous cases. To refuse to so consider the matter would be to attribute an inadmissible rôle to chance.

Nevertheless there is a difference. If the simplicity was real and profound, it would bear the test of the increasing precision of our methods of measurement; if then we believe nature to be profoundly simple, we must conclude that it is an approximate and not a rigorous simplicity. This was formerly done; but this is what we no longer have the right to do.

The simplicity of Kepler's laws, for example, is only apparent. This does not prevent their being applied, almost exactly, to all systems analogous to the solar system, but it prevents their being rigorously exact.

THE RÔLE OF HYPOTHESIS.

Every generalisation is a hypothesis; the hypothesis has then a necessary rôle that no one has ever contested. But it should always, as soon and as often as possible, be submitted to verification. It is evident, that if it does not stand this test, it must be thrown aside without regret. This is what is usually done, but sometimes with impatience.

This impatience, however, is not justifiable; the physicist who has just renounced one of his hypotheses should be glad, on the contrary, for he has just found an unhoped-for occasion of discovery. His hypothesis, I imagine, had not been lightly adopted; it took account of all the known factors which seemed to be able to intervene in the phenomenon. If the verification is not made, it is because there is something unexpected, something extraordinary; we are on the point of finding something unknown.

Has the hypothesis so rejected been sterile? Far from it. One may even say that it has rendered more service than a true hypothesis; not only has it been the occasion of a decisive experiment, but if the experiment had been made by chance, without the existence of the hypothesis, nothing would have been inferred; nothing extraordinary would have been seen; merely one fact more would have been catalogued without deducing the least consequence.

Now under what conditions is the use of hypothesis without danger?

The firm purpose to submit all to experiment does not suffice; there are still hypotheses that are dangerous; they are in the first place and above all those that are tacit and unconscious. Since we make them without knowing it, we are powerless to abandon them. Here again is a service that mathematical physics may render. By the precision proper to it, we are obliged to formulate all the hypotheses that we should make without this aid, but without being aware of their existence.

Note, besides, that it is important not to multiply our hypotheses too fast, but to make them only one after another. If we con-

struct a theory founded on multiple hypotheses, and if experiment condemns it, which among our premises must we change? It is impossible to know. And conversely, if the experiment succeeds, are we to think all the hypotheses verified at once? Have several unknowns been determined with a single equation?

Care must also be taken to distinguish between the several kinds of hypotheses. First there are those that are quite natural and without which we could hardly do. It is difficult not to suppose that the influence of very distant bodies is quite negligible, that small movements obey a linear law, that the effect is a continuous function of the cause. I will say as much for the conditions imposed by symmetry. All these hypotheses form, so to speak, the common foundation of all theories in mathematical physics. They are the last that should be abandoned.

There is a second category of hypotheses that I will qualify as indifferent. In the greater number of questions, the analyst supposes at the outset of his calculations, either that matter is continuous, or inversely that it is made up of atoms. By either method his results will be the same. If he chooses the latter, and experiment confirms his results, will he think he has demonstrated, for example, the real existence of atoms?

Into optical theories two vectors are introduced, which are regarded, the one as a velocity, the other as a vortex. This is again an indifferent hypothesis, since the same conclusions would have been reached with contrary suppositions; the success of the experiment cannot prove that the first vector is a velocity; it proves but one thing, namely that it is a vector; this is really the only hypothesis that was introduced in the premises. To give it that concrete appearance that the weakness of our intellects requires, it was necessary to consider it either as a velocity or as a vortex; likewise it was necessary to represent it by a letter, as x or y; but the result, whatever it be, will not prove that we were right or wrong to regard it as a velocity; no more can it be proved correct or not to call it x and not y.

These indifferent hypotheses are never dangerous, provided their character is not misunderstood. They may be useful, either

as artifices for calculation, or to sustain our comprehension by concrete images, to fix our ideas, as we say. There is then no reason to proscribe them.

The hypotheses of the third category are veritable generalisations. They are the ones that experiment will confirm or prove false. Verified or condemned, they will always be fruitful. But, for the reasons that I have given, this holds only if they are not too numerous.

ORIGIN OF MATHEMATICAL PHYSICS.

Let us go farther and study at close range the conditions which have brought about the development of mathematical physics. We recognise at once that savants have always tried to resolve the complex phenomenon given directly by experiment into a very great number of elementary phenomena. And this in three different ways:

First, with respect to time, instead of embracing in its entirety the progressive development of a phenomenon, we seek simply to join each instant to the one immediately preceding; it is admitted that the actual state of the world depends only on the immediate past, without being influenced by the memory of a more remote past. Thanks to this postulate, instead of studying directly the whole succession of phenomena, it is possible to write its *differential equation* representing a single epoch; for Newton's laws Kepler's are substituted.

Next, we seek to decompose the phenomenon in space. What experiment gives us, is a confused collection of facts spread over a field of considerable extent; the task is to discern the elementary phenomenon, which is localised in a very small region of space.

A few examples will perhaps make my meaning clearer. If one wished to study in all its complexity the distribution of temperature in a solid which is cooling, it would be impossible to do so. All becomes simple if we reflect that a point in the solid cannot impart heat to a distant point, but only to the nearest, and it is only gradually that the flow of heat will be able to reach other portions of the solid. The elementary phenomenon is the exchange of

heat between two contiguous points; it is strictly localised, and it is relatively simple, if it be admitted, as is natural, that it is not influenced by the temperature of molecules whose distance is sensible.

I bend a rod; it will assume a very complicated form whose direct study would be impossible; but I shall be able to attack the problem, if I observe that the flexure is only the resultant of the deformations of the very small elements of the rod, and that the deformation of each of these elements depends only on the forces which are directly applied to it and in nowise on those which may act upon the other elements.

In all these examples, which may be increased indefinitely, it is admitted that there is no action at a distance or at great distances. This is a hypothesis; it is not always true, as the law of gravitation proves; it must then be submitted to verification. If it is confirmed, even approximately, it is precious, for it is going to permit the use of mathematical physics by successive approximations at least. If it does not stand the test, something analogous must be sought, for there are still other ways to reach the elementary phenomenon. If several bodies act simultaneously, it may happen that their actions are independent and may be added together, either as vectors or as scalar quantities. The elementary phenomenon is then the action of an isolated body. Or perhaps one has to do with small movements, or more generally with small variations, which obey the well-known law of superposition. The observed movement will then be decomposed into simple movements; for example, a sound into its harmonics, white light into its monochromatic components.

When we have discerned in what direction to seek the elementary phenomenon, by what means may we reach it?

It will often happen that to predict it, or rather to predict what is useful for us, it will not be necessary to know the mechanism; the law of great numbers will suffice. Consider the example of the propagation of heat; each molecule radiates towards its neighbors, according to a law which we have no need of knowing; if we make any supposition in this regard it will be an indifferent

hypothesis and consequently useless and unverifiable. And, indeed, by the action of averages and thanks to the symmetry of the medium, all differences are razed, and whatever the hypothesis, the result is always the same.

The same circumstances are present in the theories of elasticity and capillarity; the neighboring molecules attract and repel each other, we have no need to know according to what law; it suffices that this attraction is sensible at small distances only, that the molecules are very numerous, that the medium is symmetrical, and we have but to let the law of great numbers act.

Here again the simplicity of the elementary phenomenon was hidden beneath the complexity of the observable resultant phenomenon; but in its turn, this simplicity was only apparent and concealed a very complex mechanism.

The best way to reach the elementary phenomenon would be evidently by experiment. It would be necessary by experimental artifices, to dissociate the complex beam that nature offers to our researches and study with care its elements as purified as possible; for example, natural white light can be decomposed into monochromatic lights by means of a prism and into polarised lights by means of a polariser.

Unfortunately this is neither always possible nor sufficient, and it is sometimes necessary for the mind to anticipate the experiment. I will cite but a single example which has always appealed to me.

If I decompose white light, I can isolate a small portion of the spectrum, but however small it may be, it always conserves a certain width. Similarly, the natural lights called *monochromatic* give us a very fine line, although not infinitely fine. One might suppose that in studying experimentally the properties of these natural lights, operating with finer and finer spectral beams, and passing at last to the limit, one would come to know the properties of a light rigorously monochromatic. This would not be so. Imagine that two beams start from the same source, that they are polarised in two planes at right angles, afterwards brought into the same plane of polarisation, and that one tries to make them inter-

fere. If the light were *rigorously* monochromatic they would interfere, but with our nearly monochromatic lights there would be no interference, and this however narrow the beam; it would be necessary in order to have it otherwise that the beam be several million times narrower than the finest known. Here then the passage to the limit would have deceived us; the intellect has outstripped experiment, and if this has been successfully done, it is because the former was guided by the instinct of simplicity.

A knowledge of the elementary fact permits us to put the problem into the form of an equation; it only remains to deduce from this by combination the complex observable and verifiable fact. This is what is called *integration*; it is the mathematician's affair.

It may be asked why, in the physical sciences, a generalisation readily takes the mathematical form. The reason is now easy to see; it is not merely that one has to express numerical laws; it is because the observable phenomenon is due to the superposition of a great number of elementary phenomena *all similar to each other*; in this way the differential equations are quite readily introduced.

It is not sufficient that each elementary phenomenon obeys simple laws, it is necessary that all to be combined obey the same law. It is only then that the intervention of mathematics may be useful; mathematics teaches us, in fact, to combine like with like. Its goal is to divine the result of a combination, without passing through all the intermediate steps each time. If we have to repeat several times the same operation, it enables us to avoid this repetition by informing us beforehand of the result by a sort of induction. In such cases all these operations must be similar to each other, otherwise we should have to go step by step, and mathematics would become useless.

It is thus of the approximate homogeneity of matter studied by the physicist that mathematical physics could be born. In the natural sciences, we do not find these conditions: homogeneity, relative independence of distant parts, simplicity of the elementary part; and that is why naturalists are obliged to make use of other modes of generalisation.

SIGNIFICATION OF PHYSICAL THEORIES.

Men of the world are struck to see how transient are scientific theories. After several years of prosperity, they see them successively abandoned; they see ruins pile on ruins; they predict that the theories current to-day will, after a brief delay, in their turn succumb, and they conclude that such theories are absolutely in vain. It is what they call the *bankruptcy of science*.

Their scepticism is superficial; they take no account whatever of the object and rôle of scientific theories, otherwise they would understand that the ruins are still good for something. No theory seemed so well established as Fresnel's which attributed light to movements of the ether. However, that of Maxwell is to-day preferred. Does this mean that the work of Fresnel has been in vain? No, for Fresnel's goal was not to know whether there really is an ether, whether or not it is formed of atoms, whether these atoms move in such or such a way; it was to predict optical phenomena. As for that, Fresnel's theory enables us to do this to-day as well as it did before Maxwell. The differential equations are always true; they may always be integrated by the same methods and the results of this integration ever preserve their value.

Let no one say that we thus reduce physical theories to simple practical recipes; these equations express actual relations, and if the equations remain true, it is because these relations preserve their reality. They teach us, now as before, that there is such and such a relation between this thing and that; only, something which we called *movement* before, we now call *electric current*. But these names were only images substituted for the real objects that nature will forever hide from us. The true relations between these real objects are the only reality that we can reach, and the sole condition is that the same relations shall exist between these objects as between the images we are forced to put in their place. If these relations are known to us, what matters it if we judge it convenient to replace one image by another?

That a given periodic phenomenon (an electrical oscillation for instance) is really due to the vibration of a given atom which,

behaving like a pendulum, is displaced in such or such a way, all this is neither certain nor interesting. But that there is between the electrical oscillation, the movement of the pendulum, and all periodic movements an intimate relationship which corresponds to a profound reality; that this relationship, this similitude, or better this parallelism is continued in the details; that it is a consequence of more general principles, as the conservation of energy and least action,—this we may affirm; this is the truth that will remain forever the same in all the guises in which we may see fit to dress it.

Numerous theories of dispersion have been proposed. The first were imperfect and contained but little truth. Then came Helmholtz's, which was modified in various ways; and its author himself has imagined another based on Maxwell's principles. But the remarkable thing is, that all the scientists who have followed Helmholtz reach the same equations, from seemingly widely separated starting-points. I venture to say that these theories are all true at once, not merely because they allow us to predict the same phenomena, but because they express a true relation, that between absorption and anomalous dispersion. In the premises of these theories, that which is true is common to all; it is the affirmation of such or such a relation between certain things that some call by one name some by another.

The kinetic theory of gases has given rise to many objections, to which reply would be difficult, if there had been any claim that it contained absolute truth. But all these objections cannot refute its past usefulness, particularly in revealing to us the one true relation, otherwise profoundly hidden, between gaseous and osmotic pressures. In this sense it may be said to be true.

When a physicist finds a contradiction between two theories which are equally dear to him, he sometimes says: Let us not be troubled but let us hold fast to the two ends of the chain that the intermediate links be not lost to us. This argument of the embarrassed theologian would be ridiculous if we are to attribute to physical theories the sense given them by men of the world. In case of contradiction, one of them at least should then be considered false. It is no longer so if we will seek in them what is

to be sought. It may be they both express true relations and that there is contradiction only in the images with which we have dressed reality.

To those who find that we restrict too much the domain accessible to the scientist, I reply: These questions which we prohibit you from studying and which you so regret, are not only insoluble, they are also illusory and void of sense.

Your philosopher claims that all physics can be explained by the mutual impact of atoms. If he means that the same relations obtain among physical phenomena as among the mutual impacts of a great number of billiard-balls, nothing better, this is verifiable, it is perhaps true. But he means to say something more; and we think we understand him because we think we know what an impact is in itself. Why? simply because we have often seen a game of billiards. Are we to understand that God, in contemplating his work, feels the same sensations as we in the presence of a billiard match? If we do not wish to give to his assertion this fantastic meaning, if also we do not wish to give it the one I previously mentioned, then it has no meaning whatever.

Hypotheses of this nature have only a symbolic sense. The scientist should not banish them any more than a poet banishes metaphor; but he should know what they are worth. They may be useful to give satisfaction to the mind, and they will not be harmful provided they are but indifferent hypotheses.

These considerations show us why certain theories that were thought to be abandoned and definitely condemned by experiment, are suddenly revived from their ashes and recommence a new life. It is because they express true relations, and had not ceased to do so, when for some reason or other we thought it necessary to enunciate the same relations in another language. They had thus kept a sort of latent life.

Hardly fifteen years ago, was there anything more ridiculous, more quaintly old-fashioned, than the fluids of Coulomb? But nevertheless here they reappear under the name *electrons*. In what do these molecules electrified in a permanent way differ from the electric molecules of Coulomb? True, in the electrons the elec-

tricity is supported by a little, though very little, matter; in other words, they have mass. But Coulomb did not gainsay mass to his fluids; or if he did, it was reluctantly. It would be rash to affirm that the belief in electrons will not also undergo its eclipse; but it was not less curious to remark this unexpected renaissance.

But the most striking example is Carnot's principle. Carnot established it, starting from false hypotheses. When it was perceived that heat is not indestructible but may be converted into work, his ideas were completely abandoned; later Clausius returned to them and caused them to triumph definitively. Carnot's theory, in its primitive form, expressed, besides true relations, other inexact relations, *débris* of old ideas; but the presence of the latter did not alter the reality of the others. Clausius had but to separate them as one cuts away dead branches.

The result was the second law of thermodynamics. The relations were always the same, although these relations did not hold, in appearance at least, between the same objects. This sufficed to preserve for the principle its value. Nor have the reasonings of Carnot perished by reason of this; they were applied to matter infected with error; but their form (that is to say, their essential part) remained correct.

What I have said throws light at the same time on the rôle of general principles like the principles of least action and the conservation of energy. These principles have a very great value; they were obtained in seeking what was common in the statements of numerous physical laws; they thus represent the quintessence of innumerable observations. However, from their very generality results a consequence to which I have called attention in the preface to my *Course on Thermodynamics;* it is that they are of necessity verified. Since we cannot give energy a general definition, the principle of the conservation of energy signifies simply that there is a *something* that remains constant. Whatever new notions of the world future experiments may give us, we are certain beforehand that there is something which will remain constant, and which we may call *energy*.

Does this mean that the principle has no sense and vanishes

into a tautology? Not at all; it means that the different things we call *energy* are joined by a true relationship. But even if this principle has a meaning, it may be false; perhaps we have no right to deduce applications from it indefinitely, and yet it is sure beforehand to be verified in the strict sense of the word. How then shall we be warned when it has reached the full development that we may legitimately give it? Simply when it ceases to be useful, or when we may no longer use it to correctly predict new phenomena. We shall be sure in such cases that the relation affirmed is no longer true; for otherwise it would be fruitful; experiment, without directly contradicting a new extension of the principle, will nevertheless have condemned it.

PHYSICS AND MECHANISM.

Most theorists have a constant predilection for explanations borrowed from mechanics or dynamics. Some would be satisfied if they could account for all phenomena by the movement of molecules attracting one another according to certain laws. Others are more exacting, they would suppress attractions at a distance; their molecules would follow rectilinear paths from which they could only be deviated by impacts. Still others, as Hertz, suppress also the forces, but suppose their molecules submitted to geometrical connections analogous, for example, to those of articulated systems; they thus wish to reduce dynamics to a sort of kinematics. All, in a word, wish to bend nature into a certain form, lacking which their minds cannot be satisfied. Is nature flexible enough for this?

I have already put the question in the preface to my work: *Electricity and Optics*. I have shown that every time the principles of energy and of least action are satisfied, not only is there always a mechanical explanation possible, but there is always an infinity of them. Thanks to a well-known theorem on articulated systems due to Koenigs, it may be shown that everything may be explained in an infinite number of ways by connections after the manner of Hertz, or else by central forces. Without doubt, it might be just

as easily demonstrated that everything may be explained by simple impacts.

For this, bear in mind, it is not sufficient to be content with ordinary matter, which comes in contact with our senses and whose movements we observe directly. Ordinary matter may be conceived either as formed of atoms whose inner movements escape us, the displacement of the whole being alone accessible to our senses, or one of those subtle fluids may be imagined which, under the name *ether* or other names, have always played such an important rôle in physical theories.

Often one goes farther and regards the ether as the only primitive matter, or as the only true matter. The more moderate consider ordinary matter as condensed ether, which is in no way startling; but others reduce still further its importance and see in matter only the geometrical locus of the singularities in the ether. Thus, for Kelvin, what we call *matter* is but the locus of the points at which the ether is animated by vortex motions; for Riemann, it was the locus of the points at which ether is constantly destroyed; for more recent writers, Wiechert or Larmor, it is the locus of the points at which the ether has undergone a sort of torsion of a very particular kind. Taking any one of these points of view, the question arises in my mind, by what right do we apply to the ether, under pretext that it is true matter, the mechanical properties observed in ordinary matter, which is but false matter?

The ancient fluids, caloric, electricity, etc., were abandoned when it was seen that heat is not indestructible. But they were abandoned also for another reason. In materialising them, their individuality, so to speak, was emphasised, gaps were opened between them. It was necessary to fill in these gaps when the sentiment of the unity of nature became stronger, and when the intimate relations binding all parts were perceived. In multiplying the fluids, not only did the ancient physicists create unnecessary entities, but they broke down real ties. It is not sufficient that a theory does not affirm false relations, neither must it hide true relations.

Does our ether actually exist?

We know whence comes our belief in the ether. If light takes several years to reach us from a star, it is no longer upon the star nor yet upon the earth; but it must be somewhere, and supported by some material agency.

The same idea can be expressed in a more mathematical and abstract form. What we note are changes undergone by material molecules; we see, for example, that our photographic plate experiences the consequences of phenomena of which the incandescent mass of a star was the theatre several years ago. Now, in ordinary mechanics, the state of the system studied depends only on its state at the moment immediately preceding; the system satisfies certain differential equations. On the other hand, if we did not believe in the ether, the state of the material universe would depend not only upon the state immediately preceding, but also upon much more ancient states; the system would satisfy equations of finite differences. It is to obviate this transgression of the general mechanical laws that we have invented the ether.

This would oblige us to fill the interplanetary space with ether, but not to make it penetrate into the midst of material media. Fizeau's experiment goes farther. By the interference of rays that have passed through water or air in motion, it seems to show us two different media penetrating each other and yet moving with respect to each other. We all but touch the ether.

Situations may be conceived in which we can touch it closer still. Suppose Newton's principle of the equality of action and reaction is not true if applied to matter *only* and that this is demonstrated. The geometrical sum of all the forces applied to all the material molecules would no longer be zero. It would be necessary, if we did not wish to change the whole science of mechanics, to introduce the ether, in order that the action that matter here apparently undergoes should be counterbalanced by the reaction of matter on something.

Or again, suppose we discover that optical and electrical phenomena are influenced by the movement of the earth. It would follow that these phenomena could reveal to us not only the relative movements of material bodies, but also what would seem to be

their absolute movements. It would again be necessary to have an ether, in order that these so-called absolute movements should no take place with respect to empty space, but with respect to somet thing concrete.

Will this ever be accomplished? I do not cherish the hope, and I will say shortly why. And yet, it is not so absurd since others have entertained it. For example, if the theory of Lorentz were true, Newton's principle would not apply to matter *alone*, and the difference would not be very far from being accessible to experiment. On the other hand, many experiments have been made on the influence of the earth's movement. The results have always been negative. But if these experiments have been undertaken, it is because we were not sure beforehand, and indeed according to the reigning theories, the compensation should be only approximate, and we should expect to see improved methods give positive results.

I think that such an experiment is illusory; it was none the less interesting to show that a success of this kind would open in a certain sense a new world.

And now allow me to digress slightly; I must explain why I do not believe, in spite of Lorentz, that more exact observations will ever make evident anything else than relative displacements of material bodies. Experiments have been made that should have disclosed the terms of the first order; the results were negative; can that have been by chance? No one has admitted it; a general explanation was sought, and Lorentz found it; he showed that the first order terms should cancel each other, but not the second order terms. Then more precise experiments were made, which were also negative; neither could this be a result of chance; an explanation was necessary and was found; they are always found; hypotheses are what we lack the least.

But this is not enough; who does not think this leaves too important a rôle to chance? Would it not be also a chance that this singular concurrence would cause a certain circumstance to destroy the terms of the first order, and that a totally different circumstance should cause those of the second order to vanish? No, it is

necessary to find the same explanation for the two cases, and everything tends to show that this explanation would serve just as well for the higher order terms, and that the mutual destruction of these terms will be rigorous and absolute.

ACTUAL STATE OF THE SCIENCE.

In the history of the development of physics two opposite tendencies are to be distinguished. On the one hand, at each instant new relations are discovered between objects which seemed destined to remain forever separated; scattered facts cease to be strangers to each other; they tend to arrange themselves into an imposing synthesis. Science marches towards unity and simplicity.

On the other hand, observation reveals every day new phenomena; they must wait for their place a long time; and sometimes to make one, a corner of the edifice must be demolished. In the known phenomena themselves, where our crude senses indicate unity, we perceive details more varied from day to day; what we thought to be simple becomes complex and science seems to march towards diversity and complication.

Of these two opposite tendencies each of which seems to triumph in turn, which will win? If the first, science is possible; but nothing proves this *a priori*, and possibly after vain efforts to bend nature in spite of herself to our ideal of unity, submerged by the ever-mounting flood of our new riches, we shall be compelled to renounce classifying them, abandon our ideal, and reduce science to the recording of innumerable recipes.

We cannot reply to this question. All that we can do is to observe the science of to-day and to compare it with that of yesterday. From this examination we may doubtless draw some conjectures.

A half century ago, hopes were high. The discovery of the conservation of energy and of its transformations had just revealed the unity of force. It showed also that the phenomena of heat could be explained by molecular movements. The nature of these movements was not exactly known, yet no one doubted but that it soon would be. For light, the work seemed completely done. As

concerns electricity, the advancement was less great. Electricity had just annexed magnetism. This was a considerable step towards unity, and a definite one. But in what way was electricity to enter in its turn into the general unity, how was it to be included in the universal mechanism? No one had any idea. The possibility of this reduction was not doubted by any one; they had faith. Finally, as to what concerns the molecular properties of material bodies, the reduction seemed still easier; but all the details were hazy. In a word, the hopes were vast, they were strong, but they were vague.

To-day what do we see? In the first place, a step in advance, an immense progress. The relations between electricity and light are now known; the three domains of light, electricity, and magnetism, formerly separated, are but one now; and this combination seems definite. This conquest, nevertheless, has cost us some sacrifices. Optical phenomena enter as particular cases in electrical phenomena; as long as the former remained isolated, it was easy to explain them by movements thought to be known in all their details; that was easy. But now an explanation, to be acceptable, must be readily applicable to the whole electrical domain. This often causes difficulty.

The most satisfactory theory we have, is that of Lorentz; it is unquestionably the one that best explains the known facts, the one that sheds light on the greatest number of true relations, the one in which are to be found the most traces of definite construction. Nevertheless, it still possesses a serious fault, as I have above shown; it is in contradiction with Newton's principle of the equality of action and reaction; or rather, in the eyes of Lorentz, this principle is not applicable to matter alone; in order to be true, it must take account of the actions exerted by the ether on matter, and of the reaction of matter upon the ether. At present it seems most probable that things do not happen in this way.

However this may be, thanks to Lorentz, the results of Fizeau on the optics of moving bodies, the laws of normal and anomalous dispersion and of absorption have been connected together and with the other properties of the ether by bonds that doubtless will

not break. Look at the ease with which the Zeeman effect found its place, and even helped to classify the magnetic rotation of Faraday which had remained rebellious to Maxwell's efforts. This facility proves that Lorentz's theory is not an artificial assemblage destined to give way. Probably it should be modified, but not destroyed.

Lorentz had no other ambition than to include in a single whole all the optics and electrodynamics of moving bodies; he made no pretense to give a mechanical explanation. Larmor goes farther; keeping of Lorentz's theory what is essential, he grafts on it MacCullagh's ideas on the direction of the movement of the ether. However ingenious this effort may be, the fault in Lorentz's theory remains, and is even aggravated. According to Lorentz, we do not know what the movements of the ether are; thanks to this ignorance, we might suppose them such as compensated those of matter and re-established the equality of action and reaction. With Larmor, we know the movements of the ether, and we can demonstrate that the compensation does not take place.

If Larmor has to my mind failed, does that mean that a mechanical explanation is impossible? Far from it: I said above that as long as a phenomenon obeys the two principles of energy and least action, it permits of an infinite number of mechanical explanations. It is the same for optical and electrical phenomena.

But that does not suffice: for a mechanical explanation to be good, it must be simple; in order to choose it from among all those that are possible, there must be other reasons than the necessity to make a choice. Well, a theory which satisfies this condition and which consequently might be useful, we do not posses as yet. Are we to complain? That would be to forget the end sought, which is not the mechanism, but the true and sole aim of unity.

We should then bridle our ambition; let us not seek to formulate a mechanical explanation; let us be content to show that we may always find one if we so wish. In this we have succeeded; the principle of the conservation of energy has always been confirmed; a second principle has been joined to this, that of least action, put in the form appropriate to physics. This also has always been

verified, at least as far as concerns reversible phenomena, which obey Lagrange's equations, that is to say, the most general laws of physics.

The irreversible phenomena are much more rebellious. They also, however, are being arranged and tend to enter the unity: the light which illuminates them has come from Carnot's principle. For a long time thermodynamics was confined to the study of the dilatation of bodies and their change of state. Later it became bolder and enlarged its domain considerably. We owe to it the theories of the voltaic cell and thermo-electric phenomena; there is not in all physics a corner that it has not explored, and it has even attacked chemistry. Everywhere the same laws reign; everywhere under a diversity of appearances Carnot's principle reappears; everywhere also appears that eminently abstract concept of entropy, which is as universal as energy, and like it seems to conceal a reality. Radiant heat seemed to escape it; but recently that too has been brought under the same laws.

In this way new analogies are revealed, which may often be pursued in detail; electric resistance resembles the viscosity of liquids; hysteresis resembles rather the friction of solids. In all cases, friction appears to be the type imitated by the most diverse irreversible phenomena, and this relationship is real and profound.

A strictly mechanical explanation of these phenomena has also been sought. Such is hardly possible. To find it, it has been necessary to suppose that the irreversibility is but an appearance, that the elementary phenomena are reversible and obey the known laws of dynamics. But the elements are extremely numerous and blend more and more, so that to our crude eyes all appears to tend towards uniformity, that is to say, all seems to march in the same direction without hope of return. The apparent irreversibility is thus but an effect of the law of great numbers. Only a being of infinitely subtle senses, as the imaginary demon of Maxwell, could untangle this snarl and turn the world about.

This conception, which is connected with the kinetic theory of gases, has cost great effort, and has been on the whole not very fruitful; it may become so. This is not the place to examine if it

leads to contradictions, and if it conforms well to the true nature of things.

Let us notice, however, the original ideas of Gouy on the Brownian movement. According to this *savant*, this singular movement does not obey Carnot's principle. The particles that it sets moving about are smaller than the meshes of this tightly drawn net; they should then be ready to unravel them and in that way turn the world about. One may imagine he sees Maxwell's demon at work.

To resume, phenomena long known are better and better classified; but new phenomena come to claim their place; and most of them, as the Zeemann effect, find it at once.

But we have the cathode rays, the X-rays, the uranium and radium radiations. There is a whole world that none suspect. How many unexpected guests to find a place for! No one can yet predict the place that they will occupy. But I do not think they will destroy the general unity, I think rather they will complete it. On the one hand, indeed, the new radiations seem to be connected with the phenomena of luminescence; not only do they excite fluorescence, but they arise sometimes under the same conditions as it. Neither are they without relationship with the causes producing the spark discharge under the action of ultra-violet light.

Finally, and above all, it is believed that in all these phenomena there exist ions,—animated, it is true, with far greater velocities than in electrolytes.

All this is very vague, but it will become clearer.

Phosphorescence and the action of light on a spark were regions quite isolated and consequently somewhat neglected by investigators. It is to be hoped that now a new path may be made which will facilitate their communication with the rest of science.

Not only do we discover new phenomena, but in those that we think we know, unlooked-for aspects are revealed. In the free ether, the laws preserve their majestic simplicity; but matter, properly so called, seems more and more complex; all that is said of it is but approximate and at each instant our formulæ require new terms.

Nevertheless the ranks are not broken; the relations that we have recognised between objects that we believed simple, still remain between the same objects when recognised in their complexity, and that alone is important. Our equations become more and more complicated, it is true, so as to embrace more closely the complexities of nature; but nothing is changed in the relations which permit these equations to be derived from one another. In a word, the *form* of these equations persists.

Take for example the laws of reflexion; Fresnel established them by a simple and attractive theory, which experiment seemed to confirm. Subsequently, more precise researches proved that this verification was only approximate; they showed everywhere traces of elliptical polarisation. But, thanks to the aid given us by the first approximation, the cause of these anomalies was soon found in the presence of a transition layer; and Fresnel's theory has remained in all its essentials.

It would seem, nevertheless, that all these relations would never have been noted if the complexity of the objects they joined had been known beforehand. Long ago it was said: If Tycho had had instruments ten times as precise, we should never have had either Kepler, Newton, or Astronomy. It is a misfortune for a science to be born too late, when the means of observation have become too perfect. This is what is happening to-day with physical chemistry; the founders are hampered in their estimates by the third and fourth decimals; happily they are men of robust faith.

As the properties of matter are better known, we see that continuity reigns. From the work of Andrews and Van der Waals, we see how the transition from the liquid to the gaseous state is made, and that it is not brusque. Similarly there is no gap between the liquid and solid states, and we note in their work, by the side of articles on the rigidity of liquids memoirs on the flow of solids.

With this tendency simplicity without doubt is lost; such and such an effect was represented by several straight lines; it is necessary now to join these lines by curves more or less complicated. In return unity is gained. These separated categories quiet the mind but do not satisfy it.

Finally the methods of physics have invaded a new domain, that of chemistry; physical chemistry is born. It is still quite young, but we see that already it has allowed us to connect such phenomena as electrolysis, osmosis, and the movements of ions.

From this rapid exposition, what do we conclude?

Taking all things into account, unity has become more nearly realised; this has not been as quickly done as was hoped fifty years ago, and the way predicted has not always been followed; but, on the whole, much ground has been gained.

H. POINCARÉ.

PARIS, 1900.

THEOLOGY AS A SCIENCE.

AN INVESTIGATION OF THE PART THAT THE WILL PLAYS IN RELIGION WITH SPECIAL REFERENCE TO THE PRESENT SITUATION CAUSED THROUGH THE INCREASING INFLUENCE OF SCIENCE UPON FAITH.

RELIGION and Science are as disparate and as diametrically opposed to one another as are sentiment and knowledge, or poetry with its indeterminable flights of fancy, and mathematical argument; and this fact seems sufficient to draw a line of demarcation between the two, which would keep our religious and scientific notions quite distinct and not permit either one to interfere with the other. Religion is of the heart; it is the warm devotion to the noblest cause imaginable; it is a zeal and enthusiasm for, and a faith in, an ideal that lies in spheres transcendent, while science is the ruthless unblinking investigation of facts, consisting of mental functions that may well be compared to the operations of a calculating machine, with which sentiment must not interfere, and of which the results are the more reliable the less the personal equation of subjective preferences enters into them.

This contrast between Religion and Science is not exaggerated, and so it seems to justify the old dualism that some statement may be true in religion or theology which is utterly untrue in science. Indeed artistic imagination has rules of its own and the causation of poetic dreams is different from the causation of scientific facts. The former in the domain of the latter would be lies; the latter in the domain of the former, prosaic and meaningless trivialities.

We recognise this contrast and believe fully in the right of both Religion and Science to exist in their own name with institutions that are relatively independent and not subject to one another, but correlated in harmonious alliance. Yet we do not believe in a duality of truth or a separation of the spheres of life as if there were two worlds, a realm of religion which lies in a Beyond and a domain of science which is the reality of matter in motion that surrounds us here. We believe that the fields of both are the same and that in spite of their disparity the two are inseparably linked together as husband and wife ought to be in well-ordained wedlock. When we encourage the science of religion (an investigation of the facts of religion), and come, on the other hand, to the conclusion that there is religion in science which may be formulated as a religion of science, we are perfectly aware of the difficulty of the undertaking. We do not slur over the contrast that actually and obviously exists, but on the contrary, we appreciate its significance and point out a *modus vivendi* as to how the contrast may be preserved without injury to either party, for a contrast is not a contradiction and involves conflicts only when it is wrongly interpreted and its nature misunderstood.

RELIGION.

Religion has been defined differently as belief in a deity, as devotion to the supernatural, as worship, or also as obedience to the behests of God, etc., but it is obvious that the definitions of the catechisms are one-sided; they suit the case for home use well enough but keep only in view one feature of religion. Religion is broader than its usual definitions: it affects the whole man, his heart, his head, his conduct, and there are religions which imply definite beliefs, especially the belief in God, while others do not. Buddhism, e. g., so far as its original tenets are concerned, can be taught and practiced without even the mention of the word God or a belief in him, and yet it is as decidedly, not a mere philosophy, but a religion, as is Christianity, or the Mosaic faith, or Islam, or Brahmanism, or Mazdaism. That which characterises religion is the predominance of sentiment. There is no religion without senti-

ment, but as there is no sentiment in itself; so religious sentiment has always a definite content and is characterised by a principle of conduct imparting a definite direction to the minds of its devotees. The former (the contents) is the notion upon which it is built up, the latter the moral ideal in which it finds expression. In other words: while sentiment is the core and center of religion, the sentiment feeds upon the materials furnished by the intellect and manifests itself in practical life as will.

Religion is everywhere the sentiment of adapting oneself to the ruling power of one's surroundings, and thus it presupposes a definite world-conception and implies that this world-conception serves as a guide in life. Hence there are three elements in religion: its root is of the head, consisting of the notions concerning the significance of life; in its essential nature it is sentiment; *Gefühl ist alles;* and in the average man, who is untrained in self-analysis, the religious sentiment is a mysterious mass of yearnings, hopes, fears, visions of bliss and ecstatic upliftings which defy the explanation of scientific enquiry; but its most significant feature is, after all, the impulse it gives to action. Religion is always practical; it has a moral application, and the immoral customs of savage or barbarous, and semi-civilised religions only prove that religion and morality are inseparable. An immoral religion leads to immoral practices, and a pure religion will unfailingly tend to elevate and purify conduct.

There are three distinct elements in religion: (1) doctrine, (2) piety, and (3) conduct. All three are indispensable, but now the one, now the other is emphasised. The doctrine may be blind faith, or a philosophically purified belief, or a clear scientific comprehension. A doctrine that on account of its nature strongly affects our sentiment and then becomes a principle of conduct is called a conviction; and all those convictions which affect our notion of the purpose of life in general constitute our religion.

An essential feature of a religious conviction is the recognition of its rule or principle or maxim as obligatory, for that which is acknowledged to be right or good or commendable, should, on penalty of punishment or of evil results, be carried into effect. In

other words, a religious conviction implies a duty to be performed, or a command to be obeyed.

The authority upon which the duty depends (i. e., that which renders it obligatory) need not be a personal being; it may simply be the universality of law which, when recognised, teaches us that all causes have their effects, and that evil deeds beget evil consequences. But whatever the nature of the authority, its conception as something superior exercises an educational influence; it holds up an ideal to be attained, and thus stimulates man to reach beyond and to grow above his present stature. Since the average man, even of to-day, is little trained in philosophical thought, it is but natural that he will personify the authority of conduct and think of the divine (the supreme norm of existence) in terms human, shaping God in man's own image. But whatever the authority of conduct may be, we call it God and would say that a belief in God (viz., the recognition of an authority of conduct) is an essential feature of religion.

Having broadened the conception of God so as to include all possible views, we may now, without fear of being misunderstood, fall back upon the definition of religion in terms of Christian theology and say: "Religion is the faith in, the love of, and the obedience to, God." But whatever point of view we may take, religion is always triple in its aspect: It is: (1) idea, (2) devotion, (3) deed. The idea is the product of our intellect, the devotion is sentiment, and the deed is the expression of our will.

MAN ALONE RELIGIOUS.

According to the antiquated notions of prescientific psychology, intellect, sentiment and will were three distinct powers or faculties of man, but modern psychology, having discarded the assumption of faculties, looks upon them as phases and features only in man's psychic dispositions.

The change may be best explained in the instance of memory.

We no longer believe in memory as an organ of the mind but regard it now as a general disposition of mental functions. Every sense-impression that is perceived is a psychic act; it is conscious

for a moment and then disappears from the field of consciousness. But it is not entirely obliterated; it only sinks below the limit of that mental state which is clearly felt. It ceases to be conscious and becomes subconscious. Being present in the mind, in an unconscious condition but as a definite trace, it can by a proper stimulus be revived; and we generalise this feature of mental proceedings as "memory." To conceive of memory, which is a general function, as if it were a definite faculty having its own center in a special bump of the brain, is an antiquated conception; and similarly all the faculties as distinct provinces of the mind have been done away with.

There is no definite place in the brain where sentiment has its seat nor another where the intellect operates, nor a third where the will reigns; but all, sentiment, intellect, and will, are three phases in one and the same process; they have their seats (if we may use the word) all over the organ of the mental functions and are abstract terms that designate the several significant features of the whole process.

There may be regions in the brain where either the sensation or the motor impulse is the significant feature of cerebral activity, as we have reason to assume of the several sensory and motor centers; but these centers are stations only on a longer road, and the nature of their activity is determined by their co-operation with other brain-structures. At any rate they are not isolated organs of sentiment, of thought, and of will, but interacting parts of one indivisible process; and in all actions of man these three aspects of his soul-life are indispensable, and every one of them plays an important part.

Religion is a product of experience, and thus it is decidedly a child of the intellect. Objects of inorganic nature, celestial bodies as well as the atoms of chemical reagents, are endowed with energy, but if we call their motions (by an indulgence in poetic language) actions of a will, it is a blind will only; they act, and their actions agree with the natural laws, yet they have no religion. Further, the brute creation is possessed of sensation, and we know that many animals are capable of most tender feelings, yet they

have no religion. Man alone possesses religion, because his intellect has attained the height of rationality. Man's conceptions beget religion, and man's religion can be modified by a modification of his conceptions.

Suppose a primitive man witnessing a thunderstorm is suddenly surprised by a tremendous flash of lightning which breaks down a tall tree in his immediate vicinity and is accompanied by the awful roar of a thunderclap. Think of the animistic notions he has concerning the powers of nature, his helplessness in facing them, his fear of being slain, his gratitude for having escaped, etc., etc.! What a storm of passionate feelings excites his soul! His notions concerning the power of the being that causes the thunderstorm is intensified, and he is willing to submit to its behests whatever the command may be. Or again, think of the same man seeing in a dream his deceased father, his slain enemy, a murdered friend, or some other dead person: he believes in the reality of the vision and wakes up with the idea that he has conversed with the ghost of the departed. How will he be stirred! And how quickly will he obey the commands of the spirits! The intensity of the sentiment gives power to the will, and the sentiment in its turn is the reaction of man's soul upon a definite kind of experience.

THE SUBJECTIVITY OF SENTIMENT.

Sentiment seems to us a purely subjective factor, and so will appears arbitrary. The whims of both are quite enigmatic and frequently defy a rational explanation by pure self-introspection, even on honest self-observation. The prominent part which they play in psychology and ethics has been recognised since time immemorial, and all moralists, all public orators, all educators, are agreed on this: that to gain success a reformer must work through the sentiment on the will. Our sentiments are, properly understood, we ourselves, and those sentiments that preside over and dominate our impulse ideas which in their totality are comprised under the name of "will," are the dynamic power of our mental life. The will is king.

We can easily understand how the will, being personified in the prescientific period of psychology, becomes "the thing-in-itself," and in Schopenhauer's system it is conceived as the mysterious metaphysical entity which comes to the rescue when science ceases and the dreams of metaphysics begin. The superiority of the will, as the motor power in man, being recognised, Nietzsche goes so far as to banish reason, and logic, and the entire intellect, including objectivity of truth, declaring the will in its full arbitrariness to be the autocrat of everything. The intellect is the handmaid of the will and ought to be nothing better; for truth is truth only (so Nietzsche says) if it pleases the will to be so. And these doctrines are echoed in America by a man of most conservative tendencies, Professor William James of Harvard, who has worked out a special theory of "the will to believe," cherishing the opinion that the will is justified in forming its belief according to its "organic needs," and not in compliance with arguments or scientific investigations.[1]

It is not our intention here to criticise either Schopenhauer, Nietzsche, or James; we adduce their views only to prove the importance and the necessity of a ventilation of the significance of the will. We take exception to their views. The will is not a metaphysical entity, it is not an isolated faculty, or a monarch in the commonwealth of the soul: the will is an abstract term denoting the condition of a conscious image, or notion, or idea, or plan, in the mind of man, pressing him to action.

Will implies three factors: (1) the idea, or plan, or conception; (2) consciousness or feeling, viz., a state of awareness which may be intense or weak, passionate and fitful or quiet and steady, joyous and jubilant, or painful; full of excitement or indifferent; and (3) the realisation, or at least inchoate realisation, in deeds.

[1] I may be mistaken in my conception of James, for he must not always be taken literally. He is more of a prophet than a philosopher and may in his desire to emphasise a statement easily go to extremes. Though there are many statements of his which I cannot endorse, I find him always interesting and in addition personally sympathetic. He is decidedly a noteworthy personality, and I refer to him on account of the significance which I attach to him. Should I misrepresent him, he is cor dially invited to correct my statements.

The latter is that which characterises the state as Will in contrast to feeling, and has led to the definition of will as "a state passing into act."

Accordingly there is no will which would be will pure and simple. Every will is possessed of a contents of some kind, and the contents of the will is an idea, which is a product of the intellect.

THE PERSONAL EQUATION.

Now, we grant that in all practical questions in life there is a subjective element that belongs and must belong to what may be called the personal equation. The facts that lie before us in a given case are not sufficient to form an opinion or to determine the course that a special person should take. The attitude of the person toward the facts is an important part of the whole combination, and this "personal equation" cannot be the same for all people. It will be and must be different with different personalities.

The truth is that no two persons facing the same situation, even when understanding the situation to be the same, will assume the same attitude. Thus, a recognition of the nature of the soul as a compound produces a different impression upon different idiosyncrasies. Buddha expresses it in his doctrine of the three characteristics of life, that all compounds are transitory, that their existence implies misery, and that there is no thing-in-itself, no stable ego-entity (*atman*); and he derives from it his moral teaching of unselfishness, or non-assertion, of a surrender of all clinging to worldly pleasures and a universal loving-kindness toward all beings. How different is the attitude of Omar Khayyam! Life is fleeting, there is no permanency, and our personality too is a cluster of effects without any stable entity behind it. But his conclusion is not that therefore man must renounce the impermanent and seek that which is permanent, by surrendering his egotism which is based upon the illusion of self, but on the contrary, he advises clinging to the fleeting moment, sipping the cup of joy to the dregs, and leaving all other thoughts to dreamers. To him, life has no sense except enjoyment. I note here the contrast only which con-

sists in the attitude, but must not be sought in the facts in the face of which the attitude is taken. I ought to add that there is a serious moral background in the position of the poet of wine and love, which is worked out by Goethe in such poems as "*Vanitas Vanitatum Vanitas.*"[1] In fact, Goethe's attitude is one that in a certain sense combines the opposites of Buddha and Omar Khayyam.

In brief, we grant that there is a personal equation in the moral principle of every man, and the objective statement of facts is not the sole thing in the determination of man's attitude toward his surroundings. This personal equation is due to the character of man. But we must insist, first, that the attitude toward facts is not (as James would have it) "a belief." In a scientifically trained man the will determines the attitude towards facts but not his belief in their existence or non-existence. The will may further determine the mode of expression, but not the substance of the statements themselves. And, secondly, it is obvious that the will itself is a product of experience; it has developed from blind impulses and has been modified, trained, and educated in the school of life. Its character, accordingly, its worth, its place in the scale of evolution, depend upon the growth of intelligence, i. e., the part that reason and rational considerations play in its decisions.

THE WILL.

Far from being a metaphysical entity, which is such as it is by an act of royal arbitrariness, a *sic volo sic jubeo* (as Schopenhauer teaches) the will is a phenomenon of nature, a product of definite conditions and explicable in its origin and growth. Schopenhauer commonly characterises the will as blind, meaning thereby that it lacks rationality and spurns the acute vision of intellectual comprehension. And it is quite true that the will appears to be arbitrary in its nature. The several personalities, and generally speaking all living beings, know what they will, but, as a rule, they do not know why they will it. In other words, they are conscious of

[1] For further details and a collection of Goethe's poems in this line of thought see the author's *Buddhism and Its Christian Critics*, pp. 118–121 and 98–115.

what they are, what they desire, what they want: but they are not conscious of the conditions that have moulded their nature. They are especially ignorant of their prenatal history, which built up their physiological system, the frame of the skeleton, the muscles, the intestines, the several organs of sensation, and also the inherited traits of character. Only the present is illumined by consciousness, not the past.

The lion lives on a flesh diet because he has become carnivorous in the history of his race. He does not know why; he only feels his appetite for flesh; he hunts animals as he saw his parents do; he catches his prey and devours it. For him (if he could reason about it) there is no "why?" save his royal pleasure. He likes flesh diet, it agrees with him, he feels contented when he gets it,—in short he wills it. It is his "organic need" (to use the phrase of Professor James). Logic, or ratiocination, or scientific evidence, has nothing to do with it. To the lion the slimmest pretext of an argument would be sufficient to justify his belief in flesh diet. On the other hand, no amount of the most skilful explanation of its absolute necessity will be sufficient to induce a sheep not to condemn the lion's mode of living as an utterly immoral principle.

The example of the lion's belief in flesh diet exhibits in an exaggerated way the enormous significance of the part which the personal equation plays in the formation of convictions; and on that very account it is more instructive than an instance taken from the field of arithmetic or formal logic. No one questions the statement of a mathematician that $2\times 2=4$, or that $(a+b)^2=a^2+2ab+b^2$, or if all A's are B, that every single A is B. But purely formal statements, so long as they are considered abstractly, are purely theoretical. As soon as they are applied to practical life, the quarrel of dissenting opinions begins. On the very threshold of experience, the question arises whether $2\times 2=4$ is true at all. There is a large contingent of able-minded, headstrong, stout-willed knights of thought who would declare that purely formal statements are not true: they are merely correct; that is to say, they are legitimate inferences only from assumed propositions.

The statement proves true in thousands of instances in the domain of our experience, but it may not hold good on Mars, where (for all we know) 2×2 may $= 5$. And geometrical theorems, far from being true, are positively false, for geometrical lines and points and surfaces are purely imaginary and positively unreal.

Such is the theory of John Stuart Mill as presented in his *Logic*, and if he is right, science loses its solid bottom and ceases to be reliable; but the loss of science (viz., exactness of argument and objectivity of statement) is the gain of the erratic escapadoes of subjectivity, of superstition and of all flights of fancy in the domain of unfounded belief.

If science (viz., objective knowledge) ceases, subjective opinion as fashioned by an arbitrary will exercises undisputed control. Thus the door is opened to either agnosticism or obscurantism.

Those who seek religion in the domain of the impenetrable night of nescience, who define religion as belief in the unknowable or incomprehensible, or even the impossible and incredible, whose motto is *credo quia absurdum*, would say here, "the loss of science is the gain of religion."

The attentive reader will notice that we speak of "superstition," not of "religion" here; for it is the point we intend to make that this conception of religion (as being based upon unfounded belief, as being a mere matter of subjective idiosyncracy and comparable to the lion's belief in flesh diet) is as false as is the method of laying its foundation upon scepticism.

The denial of the objectivity of truth which seems to be a disease that naturally develops in the period of transition from childhood to manhood, a kind of mental measles, leads in science to agnosticism, in religion to obscurantism. The agnostic argues there is no truth, and thus everyone's religious conviction becomes a matter of purely subjective attitude. The infidel scorns religion, saying, since truth is not forthcoming, let us acquiesce in nescience; and the pious rejoices at the idea that nothing can be either proved or disproved, for now he is free to believe anything he pleases. In both cases indolence triumphs. There is no need of troubling oneself with doubts, or investigating the problems of life. Since sci-

ence is not reliable, the personal equation of our own organic needs will solve for us all the problems of life. The will is king, intelligence is his hired servant. The will to believe alone can fabricate for us a religion that will suit us. Never mind what science has to say. Will is trump!

It is not our intention to moralise, but to explain. Says Schopenhauer: "To preach morals is easy, but to explain morality is difficult." Our intention is to elucidate the problem of the will. We do not renounce influencing others, but by affecting the comprehension we expect indirectly to affect the morals more effectually than by preaching.

The question of the will in both spheres, science and religion, has a far-reaching moral application. If our organic needs are the court of last appeal, we have only to know what we want and make a religion to suit us. We need not trouble, and we may let others do the thinking for us. It is a convenient and easy way of dealing with a grave problem, but the world will move on and may leave us behind. Our intellectual life will be arrested, for the correction of the will through better insight, through growth and higher development, is thus made irrelevant.

INTELLECT FORMING THE WILL.

Neither a truly religious nor a truly scientific man can find satisfaction in the assumption of an arbitrary will that uses the intellect as a handmaid only to do the bidding of the will. On the contrary: the will is (not directly but indirectly) the product of the intellect. And if the will were not amenable to intellectual guidance, whence should we take the courage to labor for progress, whence the hope that our life's work is not in vain? If the will were truly the ultimate *raison d'être* of our religious convictions and the authority of last appeal, there would be no sense in letting the light of science shine upon religion. Religion would be relegated to the dark region of the inscrutable, and there all superstitions, whether high or low, whether absurd or relatively true, whether inspiring by their moral significance or debasing by bigotry and error, would rank on the same level and be entitled to equal claims,

—for the criterion of judging them would have been removed and purely subjective, arbitrary needs would be deemed sufficient for their justification.

The will can be affected by instruction, it can be guided by education, it can be modified by experience. And though the influence of an improved insight is slow, it is unfailing.

Let us but consider the origin of the will, and we shall appreciate the paramount influence which intelligence exercises upon its formation.

Schopenhauer claims (and within certain limits he is right) that the will is unchangeable. Educators can improve the intellect of a man but cannot affect his character. A cat will have a hankering after birds, even though constant fear of punishment may restrain her from attacking the canary in his cage. *Mutatis mutandis*, a thief will remain a thief, a liar a liar, a rascal a rascal, even though fear of punishment may force him to reform: the character will remain as before, for no living being can change its nature, it can only adapt itself to circumstances and acquire the habit of suppressing certain impulses in consideration of their inevitable evil results. This is true enough, but we must not forget that the acquisition of new habits is actually a change of character. We grant that the growth of new habits is a slow process, and that the old habits are more inveterate than later accretions. Nevertheless, no one can doubt that education and experience in developing certain desirable habits modify the character.

There is no need of entering here into a discussion of Weismannism concerning the heredity of acquired characters, for we are concerned only with the facts of life and are not concerned with the theories invented to explain them. The fact is that men change their habits in life according to their surroundings and previous experience, and the domestication of animals proves that cats and dogs and cattle and pigeons can develop new species which all but absolutely lose qualities that were typical of their ancestors in a wild state, and they acquire others which become inbred and need very little training. The difference between Weismann and his adversaries is not a question of fact (for as to facts there is no

disagreement), but of theories as to the mode of operation. Most naturalists believe that acquired habits are transmitted as dispositions, and disposition grows into hereditary traits; which implies that nature selects those individuals for propagation which adapt themselves to conditions. Weismann believes that only such individuals acquire new habits as (according to their germinal predispositions) possess the faculty of adaptation to the special line required and thus selection is made of germs. The facts in both cases remain the same: there is evolution,—viz., a growth by epigenesis, a development of new additional faculties which did not exist before.

The fact remains that new types of beings are being moulded under our very eyes. Human races (like the negroes in the United States, the Japanese under the influence of Western civilisation, European immigrants to America) are modified. The process is slow, very slow, but not slow enough to be questioned. And it is experience under definitely given conditions that produces the change. Experience means intelligence, and it implies the objectivity of facts to which the subjectivity of sentiment becomes adapted. The product which is a change of character appears upon introspection as arbitrary as before; it is will, and the new type of creature acts according to its new habits because it wills to be such as it now is, and not because it argues on lines of logical deductions.

It is the logic of the influence of objective facts, not the subjective logic of pondering over problems, that moulds sentient beings. Hence the statement concerning great leaders on the path of progress that they builded better than they knew. Evolution in the animal kingdom and progress in the history of mankind is due to the influence of the reason or logic of the objectivity of facts upon the subjectivity of the will, of character, of sentiment. Thus sentiment, and with it character and will, are slowly but surely modified by reason.

Sentiment, character, and will are for the present purpose identical, for character is a name of the general tenor of will-impulses, and will is merely the dynamic aspect of sentiment.

EVOLUTION OF SUBJECTIVITY.

The evolution of all life must have started with simple impulses of sentient substance, and these blind impulses are the result of an internal state of irritable matter; they are due to the physical need of hunger. A need is felt as a want, and the want is an incipient will. The want incites irritable substance to activity, and a blind search for food is made. The want is sooner or later satisfied, leaving a trace of the pleasant experience, which is a predisposition for a repetition of the same process. Innumerable actions of the same kind shape the life-substance in adaptation to its surroundings. The constant touch with a surrounding medium produces a follicle or enveloping membrane with an aptitude to contract upon touch; the constantly repeated impact of ether-waves is responded to in places most exposed to them, viz., in front, and the traces of this constantly repeated response develop specks sensitive to light, called ocelli, or primitive eyes. Thus the environment shapes the several creatures, and their will is nothing but the response to given conditions. The subjectivity of every being is due to its place of growth in the objective world.

And what a bewildering multitude of forms exists in animate creation! There are innumerable bacilli, bacteria, and spores fungi and microbes. We have protists which cannot as yet be classified either as animals or plants. There are innumerable varieties of lower life, but the number of forms rather decreases with their ascent; fishes, birds, amphibia present stately groups of families, fully known only to specialists. The mammalia are sufficiently limited in number to be generally pretty well known. But when we come to the highest type, the rational animal, we have one genus only, which is man. There are about half a dozen human races, but the black and the white, the yellow and the red races differ from each other less (as regards race characteristics) than the St. Bernard from the dingo. The races of man are not *genera*, but *species*.

It is true that within the unity of the human genus there is a

great variety of individual differences, almost as great as, or perhaps even greater than, the variety of genera on the lowest scale. Still it is one genus only. This contrast between the higher and lower stages of evolution is characteristic, because it points out the power of the oneness of the aim, or goal, or ideal. This ideal of animal life is not imposed upon it as an external purpose in the old sense of the doctrine of design, but inheres in nature as an intrinsic teleology, a direction which evolution takes because it is determined by law, i. e., the immanent world-order of uniformities which naturally lead all creatures to develop toward rationality. We do not deny that on other planets other kinds of rational beings may exist; they may be winged, their organs of locomotion may be different, and they may have additional sense-organs, but they will have the same reason, and (leaving out the decimal system as accidental) the same arithmetic, the same mathematics, the same logic. There is one law only in the world which in its purely formal relations is the condition of all uniformities in the world, and corresponding to this one law there is one reason only and there can be only one ideal of rationality for rational beings. This ideal, being founded upon the objective fact of uniformity in the world-order, is an objective factor; it is the factor that moulds the intellect of living creatures, and, by moulding the intellect, fashions the will.

Will (properly speaking) is never blind, as Schopenhauer says; will develops from blind impulses, but it becomes will only by the light of intelligence which is nothing but subjectivity regulated by a recognition of the objective world-order, viz., the eternal law of being in which existence is moulded.

The idiosyncrasy of the will is unquestionably the most powerful factor in belief, religious as well as ethical. All creatures that can speak are apt to fashion their rules of conduct according to their character, the preservation of which is to them an organic need. And yet, however stable a character may be, it is not absolutely stable. There is back of it the influence of experience which is little recognised and much misinterpreted, working constantly in one and the same direction toward a recognition of the factors that shape us. The result is first a rational being with the eggshell of

superstition still clinging to him and then the completion of the rational ideal in the man of scientific insight.

SCIENTIFIC INSIGHT.

We say purposely "man of scientific insight," not "scientist"; for science is the method only, the instrument by which we realise the aims of mankind, the ideal of existence toward which evolution tends. The scientist is the hod-carrier who furnishes the materials for a scientific conception of existence. It is not probable in the advance of civilisation that all men will become scientists, but it is quite within the scope of probability that in a future condition of society all people will be possessed of scientific insight, and as soon as that stage is attained, we shall understand that above the organic need of a will to believe, there is an objective norm which shapes and moulds in the furnace of evolution the organic needs of beings, and those creatures whose organic needs are not amenable to the quiet promptings of the lessons of life will be sifted out and discarded.

Organic needs remain the court of last appeal to the rational but prescientific man. The prescientific man finds rest and peace in the thought that a certain belief is satisfactory to him, because it suits his idiosyncrasy. The man of scientific insight goes farther; he seeks his foundation in the eternal conditions that have shaped his will and thus he is enabled to grow beyond his present size. All creatures have this chance, and it is a positive fact that all creatures do grow by experience in the school of life. For it is this growth which makes evolution possible. But the man of scientific insight ceases to cling to what he is at a given moment, and thus he acquires the power of conscious growth.

In the prescientific man there is a resistance to growth and this resistance to growth is beneficial as a conservative principle: otherwise growth would not be steady, but erratic. When the stage of scientific insight has been attained, there is no further danger of haphazard advances, for then changes being based upon a clear comprehension of facts imply fewer risks and thus there is less fear

of going astray, which implies a calm confidence and a well-directed courage.

THEOLOGY.

But what has an exposition of the evolution of will to do with theology?

Very much indeed! If religion is in its most significant period of growth a condition of belief, and if in this period belief depends upon our organic need, i. e., upon the will to believe, the gradual disappearance of the subjective factor and its replacement by a recognition of the objective norm in which our will is moulded must finally transform the old theology, the pseudo-science of subjective beliefs, into a new theology, viz., theology as a genuine science. The latter is the natural outcome of the aspirations of the former as much as astronomy issues from astrology and chemistry from alchemy. We might call the new theology by a new name to distinguish it from the old theology of bygone ages, but if the transition be a peaceful change there will be no need of a new name.

We might call the new theology "theosophy," had that beautiful name not been monopolised by the theosophists whose most prominent representatives seem to be bent on continuing the errors and vagaries of the old theology without actually attaining the higher ground of the truly scientific spirit; they introduce newfangled extravagances and return at the same time to errors that have been discarded.

We might call the new theology "theonomy" (in analogy to astronomy) were it not for the fact that the ending "logy" in the sense of "science" is literally quite correct, and even "astrology" would according to its etymology be the correct term for the science of the stars. But if the term were accepted it would serve its purpose.

The new theology (or if you please "theonomy") is a new science the roots of which lie partly in philosophy, partly in a scientific treatment of history, partly in ethics, partly in an application of art, and partly also in poetry and belles-lettres, the religious literature being to a great extent hymns and recitals. The basis of

theonomy is an appreciation of the factors that shape our ends, viz., God.

The name God remains quite as appropriate for the new conception of the eternal norm of being as it was for the old. The notion of a divine personality which the term conveys is as little objectionable as is the occasional personification of nature which now and then occurs even in strictly scientific books. For there is a good reason for anthropomorphism, and if it is only understood as such, there is no need of taking offence at it. Moreover, the eternal norm of being is actually a harmonious totality of laws of nature, a system of truths, a spiritual organism, or a body of immaterial influences which condition all the details of becoming, and these creative factors of life are omnipresent as they are nonmaterial; they are eternal as they are indelible; they are immutable as they are perfect, and beyond the possibility of being improved, forming the unchangeable bedrock and ultimate *raison d'être* of existence.

But theonomy, the new theology, is not merely philosophy: it is complicated by a consideration of the positive forms of religion as it has historically developed on earth. It is history when tracing the evolution of religion from Egypt and Babylon to Palestine, from Palestine to Rome, from Rome to Germany, England, and America. It is in need of philology and literary criticism when it restores the old sense of the literature of the several religions. It partakes also of the nature of the descriptive natural sciences. It enters into psychological investigations when inquiring into the source of religious phenomena, e. g., the practice of sacrifice, of slaughtering animals, and in savage times even human beings, on the altars of the gods. It trespasses upon the territory of folklore and anthropology when tracing the development of purer views from superstitions, of moral convictions from barbarous customs, of scientifically tenable notions from a belief in magic and other errors. It partakes of the methods of the educator when applied to the practical needs of present morality. It is a grand and noble science, and the scope of its development is of infinite potentialities.

THE FUTURE OF RELIGION.

Those who speak of the irreligion or non-religion of the future have seen one side only of the religious life of the present age, viz., the decay of certain dogmatic features of the old theology and the palpable untenableness of the old position of dogmatism with its *credo quia absurdum*; they are limited in their field of vision to one aspect only and have not seen the actual growth that is taking place in the minds of theologians holding chairs of theology at the several universities of both hemispheres, and also in the hearts of religious congregations, especially of the Protestant Churches of the United States. The future of mankind will not be less religious than the past; it will be more religious; that is to say: its religion will be as much purer than the decaying credos of to-day as monotheism was better than the polytheism which it succeeded.

The present age is a time in which frequent demands are being made for a revision of creeds, and the Presbyterian Church has gone so far as to make a few important changes, and it is remarkable that the delegates were practically unanimous.

Obviously modifications in the formulation of our religious tenets have become desirable, because our comprehension has expanded and our field of vision has been enlarged as well as deepened. This change, however, is not a symptom of decay and death, but of growth and life. We find it necessary to discard the old dogmatism. Yet while dogmatism should go, dogmas (or rather doctrines) should stay, and they will stay. That is to say: our attitude toward the traditional confessions of faith, our interpretation of them, our views concerning their letter and the relation of the letter to the spirit, has changed, and the change actually consists in a better knowledge of their spirit.

Thus the future will not be less religious but more religious, and our religion will be purer and nobler and truer.

We shall understand the way in which the intellect modifies the will, and we shall see the justice of interpreting the traditional dogmas in the light of science. We need not drop the symbol as

a myth, when we begin to understand its significance, nor need we abandon the name and conception of God when we learn that God is not an individual being, but a superpersonal omnipresence.

Religion, far from being abolished, is at present in a stage of growth. Its horizon is expanding, but instead of losing anything, we are gaining. Theology changes into theonomy, which is not a surrender of the old orthodoxy, but its fulfilment and completion.[1]

THE REVISION OF CREEDS.

Now it may seem strange that supposing I myself had been a delegate to the Presbyterian assemblage or committee, I should (in spite of my radical position and advanced views) have voted against a revision of the creed. And why? Because I would propose another course which seems to me more recommendable.

To revise creeds seems to imply that their formulation in a past age was a mistake, and I think it was not. A creed is a formulation of faith as understood at the time of its formulation and under definite historical conditions. We can understand the spirit of a creed only after a close study of the history of the time which gave birth to it, and to adapt a creed of the past to the needs of the present must forever remain patchwork. And it would be wrong to tamper with creeds, for they are historical documents and should be as little altered as we would change the text of ancient monuments.

The revision of a creed, too, is an historical act, and so the changes adopted indicate a change in the religious attitude of a Church, but it would have been preferable to leave the old confession alone.

In place of a revision I should have proposed a new statement made of the spirit in which the present generation views the con-

[1] The change pointed out here does not lead to agnosticism or negativism of any kind, but toward the establishment of a positive science of religion, including the nature of God. While we grow broader, we become more tolerant and sympathetic with other conceptions, but also more definite in comprehending the truth, viz., the orthodox solution of religious problems. For details see the writer's article "The New Orthodoxy" in *The Monist*, Vol. VI., No. 1, and in *The Dawn of a New Era*, p. 21 ff.

fessions of faith in the past, and my proposition, which I trust would be acceptable to the most orthodox wing of the Church, would read about as follows:

WHEREAS, divine revelation is the unfoldment of truth;

WHEREAS, God speaks to mankind at sundry times and in divers manners;

WHEREAS, Jesus Christ spoke to us in parables, and the Christian confessions of faith are, as their name implies, symbolical books;

WHEREAS, religion is a living power and life means growth;

WHEREAS, that is the true light which lighteth every man that cometh into the world; and finally

WHEREAS, centuries of unparalleled growth have added much to our better comprehension of religious truth:

THEREFORE, be it resolved that we, the duly elected representatives of the Presbyterian Church, declare

That we regard the Westminster Confession of Faith and other formulations of belief in ages past contained in the symbolical books, as venerable historical documents which were, from time to time, on certain occasions, and for specific purposes, composed by the legitimate and legally appointed representatives of our Church;

That we justify the spirit in which they were written, but deny that they were ever intended to bar out from us the light that the higher development of science and the general advance of civilisation would bring;

That we bear in mind that the symbolical books are symbols, and that we have learned that a freer scope for their interpretation in the light of the maturest science of our age will do no harm to the essential doctrines of our faith.

This declaration would bestow the necessary liberty of conscience on Presbyterian ministers without involving the change of a single letter in the Westminster Confession and without causing a break in the historical tradition of the Church.

While I am radical in my principles and do not hesitate to apply my radicalism to practical life, the very recognition of evolution as an essential truth in the interpretation of the development of man teaches me to be conservative. Such a radicalism as would tear down religion on account of some antiquated expressions is shallow and will not prove wholesome. It is a spurious radicalism. We must learn to comprehend the old formulations of faith from the standpoint of the old times. We must recognise the sincerity of our fathers and appreciate the work they did. Let there-

fore their work stand *as theirs*. On the other hand, we must not allow the dead to govern the living, and the past to cripple the life of the present.

It is true that the authors of the Westminster Confession fondly imagined that their statement would prove acceptable to all the generations to come; they did not consider the needs of the twentieth century. But that narrowness which characterised them is a trait of their age and we cannot appreciate the moral worth of their zeal unless we bear in mind their limitations.

The Huguenots endured most dreadful persecutions, they were exiled from France, they lost all their worldly possessions in their old homes; but they carried with them confidence in liberty, boldness of enterprise, good schooling and knowledge, sound methods of education, thrifty habits, energy and endurance. It is no accident that they became prosperous wherever they went. History is their justification. We make ourselves worthy of the heirloom of their deeds, not by clinging to their limitations, but by imitating their boldness of spirit and their love of truth—of the truth as they saw it—which made them rise in rebellion against the tyranny of the letter of the established Church institutions.

When we lay our hands on the plow, there is no need of looking back. We should learn to understand the past, but we should live within the living present; and we of the present have the same right to think, to learn, and to grow as our ancestors had. We have the same right to reform the Church as they had, and also to formulate our views of religious truth in terms that will suit the needs of the present time. We are their descendants; our faith is the outcome, and in part the product, of their religious development, and if it is not the same in letter, it is the same in spirit. Our faith is their faith; but it is their faith matured by the increased experience of several centuries. There is no need of tampering with their statements and of changing their confessions of faith. If we only recognise our own right to read the old doctrines in the new light, we shall be more just to them and give them a better interpretation which at the same time will be better adapted to the conditions under which we live.

Religious truths were formulated for the sake of rendering clear the situation in which they were written, but they were never meant to arrest mental development. The men who wrote the Westminster Confession would not express themselves to-day in the same terms as they did then. In their days they reformed the Church, because they insisted upon their right to think, to learn, and to grow; they would not to-day be prevented from acting on the same principles, and under changed conditions they would express their faith in other terms. Let us follow their example and so prove ourselves to be their faithful successors, their legitimate heirs and true children, not in the letter, but in the spirit.

What is true of the Presbyterians holds good for all Churches. There is no need of revising dogmatic formulas or tampering with any confession of faith. Let all creeds stand as they read and treat them as historical documents; but when you feel that you have outgrown the letter of your religious traditions, remember that creeds are symbols of your faith, not absolute truth, and insist on your right of interpretation.

We need elasticity in our religious life as well as stability. The right of interpretation gives both: It frees us from the bondage of the letter that killeth, yet preserves the spirit. It allows a great scope to liberty on conservative principles and favors growth without producing a break, thus rendering evolution possible where otherwise a revolution would be necessary.

EDITOR.

THE CREATION-STORY OF GENESIS I.

A SUMERIAN THEOGONY AND COSMOGONY.

MYTHS IN THE BIBLE—is a subject which has recently received the greatest attention from Biblical scholars. Professors Gunkel[1] and Zimmern[2] have investigated the subject in its various aspects, and Dr. Paul Carus[3] has discussed it so thoroughly that hardly anything is left which has not been adverted to by them. The following investigation is based upon a direct study of the ancient Babylonian inscriptions, though the results reached by my predecessors and a thorough acquaintance with their method of investigation is presupposed here. For the sake of completeness, however, I may be permitted to recapitulate in a few words the chief data brought out by their investigations, confining myself here to the myth of the first chapter of Genesis.

The original account of Gen. i. must have contained the so-called Jahveh-Tehom myth found in other parts of the Old Testament. This myth represents Jahveh as fighting with a dragon, called either Rahab or Leviathan or serpent. Jahveh overcomes this dragon, divides it and forms out of the two halves "the waters that are above the firmament" and "the waters that are below the firmament." The Biblical dragon has been identified with the

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[1] *Schöpfung und Chaos in Urzeit und Endzeit.* Göttingen, 1895. Also his new *Commentary on Genesis* (the *Introduction* has been published by the Open Court Publishing Co., Chicago).

[2] "Biblische und Babylonische Urgeschichte" in *Der alte Orient*, Vol II., Heft 3. Leipzig, 1901.

[3] "The Fairy-Tale Element in the Bible," in *The Monist* for April and July, 1901.

Babylonian Tiâmat, a monster which was overcome by the god Marduk, the god of light, and which was likewise divided in twain. Further the fight of Marduk with Tiâmat was recognised as the original of the fight of Jahveh with Tehom: a fight of the light against the darkness. The darkness having been overcome by the light, the creation became possible. The following striking similarities were found to exist between the Biblical and Babylonian myths[1]:

According to both traditions there was in the beginning nothing but the chaos under the form of the primeval ocean—it was eternal, not having been created. This ocean, when personified was thought to be a terrible monster. The Babylonian name of that monster was Tiâmat, the Biblical Tehom or Leviathan-Rahab.[2] That in Gen. i. this Tehom was considered a mythical being is still evident from the fact that the word is treated as a "proper name"—it is simply called Tehom and not ha-Tehom. In both myths this Tehom is represented as a dragon or serpent, either with one or several heads, presumably seven as in Revelation, chapters xii. and xiii.

Besides the chief monster there appear in both traditions *others: its helpers.* In the Babylonian creation-story there are opposed to these monsters the "great gods" among whom Marduk takes the first and foremost place. Also in the Biblical account there seem to have been, besides Jahveh, other divine beings, as is still evident from Gen. i. 26: "Let *us* make man." In the Babylonian account it is Marduk who takes up the fight with Tiâmat; in the Biblical account the same rôle is played by Jahveh. Both are armed with a sword. Marduk kills with his sword Tiâmat, Jahveh Rahab-Leviathan-Tehom. The "helpers" of Tiâmat are treated more kindly by Marduk, precisely as is done with the helpers of Rahab by Jahveh. According to both myths the monster is divided—according to the Babylonian account: into the upper waters and into the lower waters. The upper waters are kept back by a kind of

[1] See Zimmern, *l. c.*, p. 15. Gunkel, *Commentary*, p. 85 f. Carus, *The Monist*, April, 1901, p. 428.

[2] ψ lxxxix. 9 ff. ψ lxxiv. 13 ff. Is. li. 9 ff. Job xxvi. 12 ff.; ix. 13 ff.

barrier and by watchmen, who are "not to let out the waters." According to the Biblical account Jahveh divides the Tehom, the primeval ocean, also into two parts, by putting a firmament between them. Thus the Tehom came to be a heavenly and a terrestrial ocean, or as it is said in the Bible, "waters which were above the firmament" and "waters which were below the firmament." Even the watchmen who are to guard the waters of heaven are still preserved in Job vii. 12:

"Am I a sea or sea-monster that thou settest a watch over me?"

By thus dividing the primeval ocean there is created according to both myths the visible heaven. In the Bible as well as in the Babylonian account this fight with the dragon is closely connected with the creation of the world, in such wise that the former precedes the latter. In both accounts we have the following sequence: Tehom—Fight—Division—Heaven!

The above is a *résumé* of what scholars have arrived at in their investigations, and I think their conclusions may be accepted as true. But, far as they have gone, they have by no means as yet exhausted the subject. There are still left certain difficulties in the Biblical as well as in the Babylonian account which are not yet satisfactorily explained. And with these unsolved problems we are concerned here.

Before we consider these problems it would seem necessary to say a few words about the structure of Gen. i.

The first chapter of Genesis is ascribed by all scholars to the Priestly school (commonly abbreviated P.)—and is hence late. The word אלהים (Elohim) is used throughout for "God" and the account is built up according to a certain formula. This formula runs:

"And Elohim said: let there be . . . and there was. . . . And Elohim saw . . . that it was good. And there was evening and there was morning the . . . day."

According to this skeleton the creation of the world is described as having taken place within a space of seven days. This system of seven days is not original, it is not found in the Babylonian account. It was inserted by P. This follows from the fact that on

the third and sixth day two tasks were done, and that on the seventh day, which was intended to be a day of rest, Elohim had to *finish* the work of the sixth day: ויכל אלהים ביום השביעי מלאכתו אשר עשה[1] —and if he *finished* it, he had to *work* on it, it was not at an end, not yet done on the sixth day! But, as we shall shortly see, there is still another reason why the system of seven days cannot have belonged originally to the account of the creation.

Furthermore, I should like to point out here the difficulty which we encounter when trying to translate the word הארץ. It is used in three different senses in the first ten verses. In the expression, את השמים ואת הארץ, it is used to express our idea of "cosmos," for "heaven and earth" is simply the Hebrew term for our word "cosmos." In the expression, והארץ היתה, of v. 2, ארץ stands for the chaotic mass; it is the cosmos as it existed *before* the first day. And v. 10 ארץ is explained by יבשה, "the dry ground"; here therefore it is the same as that which we should understand by "earth." Bearing this in mind, we ought to translate verses 1—3 as follows:

"In the beginning of the Elohim's creating[2] heaven and earth (i. e., the cosmos)—the chaotic mass existed,[3] namely,[4] as a tohu vabohu, and darkness was upon Tehom and the spirit of Elohim מרחפת upon the waters—then Elohim said:" etc.

With this translation, of course, falls also the theory of a *creatio ex nihilo*. Indeed, a creation out of nothing is not implied in the first chapter of Genesis. Not a single word indicates such a theory—not even the word ברא—for we have instead of ברא in verses 25, 26, the verb עשה. It was the chaotic mass coeternal with the Creator out of which everything was created, made, developed, evolutionised. After the primeval ocean has been divided into the waters above and below the firmament, the earth or dry land is made to "appear out of the waters under the firmament": ותראה

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[1] Gen. ii. 2.

[2] Or, "In the beginning when Elohim was about to create."

[3] היתה = "existed," not ויהי or "became."

[4] Sc. at that time, i. e., "in the beginning."

היבשה! Even the birds are developed or take their origin from out of this terrestrial ocean:

ישרצו המים שרץ נפש חיה ועוף

"Let the waters swarm with swarms of living creatures and with birds."[1]

We see then, that one thing takes its origin out of the other, one is the parent of the other; there is, so to speak, a continual giving birth of one thing to another,—a *genealogy*.[2]

Having thus cleared our way, we must now consider the *differences* between the Biblical and the Babylonian account of the creation,—differences that are certainly strange and marked. If it be true that Gen. 1 originally made use of the fight of Jahveh with Tehom, we must be able to account not only for its omission, but also for its differences from the Babylonian Marduk-Tiâmat myth. And just these differences are, for our consideration, of the highest importance!

According to the Babylonian account, the creator Marduk was *himself borne* by Tiâmat,—he therefore was not coeternal with Tiâmat, he was, so to speak, her child! The Creator of Gen. 1, on the other hand, exists from all eternity like Tohom herself! The *first* act of the Babylonian creator is the "division of the Tiâmat," i. e., the creation of "the upper waters" and "the lower waters"! The first act of Elohim of Gen. 1 is the creation of the אור or light.

Now, what is the significance of this אור in Gen. 1? It is

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[1] Gen. i. 20.

[2] The writer of Psalm civ. 24 ff. was, no doubt, later than P., since for him the eternity of Tehom-Leviathan seemed to have been impossible. Jahveh alone could be eternal,—hence Leviathan had to become a creature, for we read (R. V.):

"O Lord, how manifold are thy works!
In wisdom, thou hast made them all:
The earth is full of thy creatures.
Yonder is the sea, great and wide,
Wherein are things creeping innumerable,
Both small and great beasts.
There go the ships,
There is *Leviathan*, whom thou hast formed
to take his pastime therein!"

The original significance of Leviathan is lost here,—he has become a mere creature of Jahveh! Hence also the succession: creation of the earth with its creatures and the sea with its creatures, among them Leviathan!

neither the sun nor the moon nor any of the stars,—for they were all created later: on the fourth day! And yet it is said in v. 4 that Elohim by thus creating the "light" *divided* the "light from the darkness"; the former he called "day," the latter he called "night." Now this is in direct contradiction to v. 14 and v. 18, where we are expressly told that Elohim created the "two great luminaries," i. e., the sun and the moon, "to rule over the day and over the night and to *divide the light from the darkness*"! According to our daily experience and observation, it is the *sun* which conditions "the light and the darkness" or "the day and the night." If this be true, then it follows that the statement in v. 4 about the "light" of the first day is wrong. And so it is! We saw above that the system of seven days does not originally belong to the creation story. The writer of Gen. 1, however, in order to fabricate his nights and days or simply "days" before the sun was created, *had to add* some such expressions as those found in v. 4: "to divide the light from the darkness." In doing this, he manufactured the first three days,—*the days*, namely, which preceded the creation of the sun on the fourth day. And because it was *added*, it follows that v. 4 and all of v. 5 does not belong to this account. But this consideration does not yet explain the "*light*" itself, created by God on the first day.

In vain have I looked in the various commentaries for an explanation,—the explanations given, if they may be called such, do not explain! Here again the Babylonian account helps us. According to that account Tiâmat brings forth "the great gods," among whom the *god of light*, Marduk, was the chief one, and this latter overcomes Tiâmat and thus creates the heavens. In Gen. 1 the monotheistic idea predominates; the conception of divinity that the writer had, did not suffer the Creater himself to be created,—hence what did the writer do? Well, "the great gods" were eliminated, the creator Marduk was called Elohim (or Jahveh) and was made coeternal with Tiâmat and placed with her at the beginning, —but only the NAME, *the nomen proprium of the creator was removed*, his attribute was kept: the attribute "*light*"! And it was kept because the writer NEEDED it to make out his DAYS! Hence the

"*light*" of Gen. 1, 4, because it is neither the sun nor the moon nor any of the stars, can be only the *attribute of Marduk*, as the god of light and the foremost of all gods. The "*light*," then, must be *another*, and the most important, mythological element taken from the Babylonian account by the writer of Gen. 1. Marduk, the "god of light," is the "*conditio sine qua non*" without which the creation would have been impossible,—the writer thought. The name Marduk had to be given up, but his attribute could be kept and was kept and made the *first work* of Elohim.

From these considerations we get the following sequence:

(*a*) Babylonian:

Tiâmat—"the great gods," and Marduk, the *god of light* —fight—division—heaven.

(*b*) Biblical:

Tehom—light—fight—division—heaven.

In the Babylonian account the *primeval ocean* is a monster of double sex: a masculine and a feminine in one person, a kind of androgyn, for we read:

"E-nu-ma e-lish la na-bu-u sha-ma-mu
shap-lish ma-tum shu-ma la zak-rat
apsû-ma rêsh-tu-u za-ru-shu-un
mu-um-mu ti-amat mu-al-li-da-at gim-ri-shu-un
mê-shu-nu ish-ti-nish i-chi-qu-u-ma."

That is:

"When above | the heavens were not yet named
Below the earth | no name as yet bore
When the *ocean*, the primeval | their *begetter*
Tiâmat, the deep, | the *mother* of them all
Their waters in one | had joined together
Then the great gods were created."

According to this the primeval waters consisted of the *apsû*, the *begetter*, or zârû,[1] and the *Tiâmat*, the *mother* or muallidat. As a result of the "joining their waters in one," i. e., of cohabitation, the gods were created. The primeval ocean, then, was considered to be the *first parent* who brought forth the gods. What does the

[1] From the root זרע "seed"!

Bible say to this? The verse which speaks about the primeval waters consists of three clauses—the first clause gives the description of the primeval waters or chaotic mass and the other two clauses stand in the so-called parallelismus membrorum. It reads (v. 2):

והארץ היתה תהו ובהו
וחשך על־פני תהום
ורוח אלהים מרחפת על־פני המים

That is, "the chaotic mass (or primeval waters, ocean see above!) existed as a tohu-vabohu; it was 'a darkness' upon the *Tehom* as well as a 'spirit of god' that מרחפת upon *the waters*."

If the Hebrew Tehom is equal to the Babylonian Tiâmat, then "the waters" must be the "apsû." But if "the waters" are the "apsû," then "the spirit of God" must be it too! This follows from the parallelism. Hence "the spirit of God" of Gen. i. plays exactly the same rôle as the apsû of the Babylonians, i. e., he מרחפת the Tehom. The word מרחפת is declared by the newest commentators to mean "to brood over"—but I do not think that that translation exhausts its full meaning; מרחפת means and stands for the same "idea" expressed by the Greek ἐπισκενάζειν, i. e., "to overshadow." Thus we get here a striking parallel to "the Holy Ghost overshadowing Mary." מרחפת, then, expresses the same thing as does the Babylonian "joining their waters in one."[1] If this be true then even in Gen. i. we find the thought expressed that the primeval waters or ocean are *parents*, who beget and would bring forth!

Thus here we have another striking similarity—notwithstanding its great difference—between the Biblical and Babylonian accounts of the creation! In both accounts the primeval waters were thought to be a kind of androgyn, male and female in one person, who thus became the first parents.

The writer of Gen. i. who apparently did not believe in an androgynous monster, retained the Tiâmat or Tehom, but substituted for the apsû "the Spirit of Elohim"[2] as the life-giving power of

[1] From this it also follows, of course, that the expression has nothing to do with the world-egg theory, which some scholars want to find here.

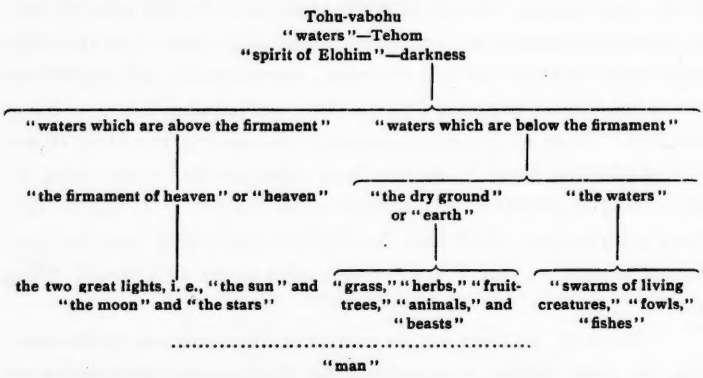
[2] The expression "spirit of Elohim" seems to stand in P. for the same idea as

everything. He wanted, it is true, to eliminate the androgynous character of the primeval ocean—the result we know.

Again if the Tehom is = Tiâmat, then חשך (the darkness) must be = Tiâmat too. Thus it was rightly said that the fight of *Marduk* with *Tiâmat* is nothing more or less than a fight of the *light* against the *darkness*.

But we have seen above that the god Marduk was called Elohim and made coeternal with Tehom, and that simply his *attribute* was retained by the writer of Gen. i. in order to help him to fabricating his days. We also have seen that the functions of the אור are in contradiction to those of the sun, and thus must be spurious, i. e., אור does not belong to the original account of Genesis;[1] it *must be left out*, if we would restore Gen. i. to its original text.

Bearing this in mind the account of Genesis i. contains a well connected genealogy, which is as follows:


Tohu-vabohu
"waters"—Tehom
"spirit of Elohim"—darkness
"waters which are above the firmament"
"waters which are below the firmament"
"the firmament of heaven" or "heaven"
"the dry ground" or "earth"
"the waters"
the two great lights, i. e., "the sun" and "the moon" and "the stars"
"grass," "herbs," "fruit-trees," "animals," and "beasts"
"swarms of living creatures," "fowls," "fishes"
"man"

I would draw the reader's attention here to the fact that "the waters above and below the firmament" are said to come from the Tehom, or the darkness,[2] a peculiarity which will be explained later on.

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the מימרא of the Targums! It was used in order to avoid as much as possible the "anthropomorphic idea" of God.

[1] If it did it ought to be made coeternal with Jahveh-Elohim, as Marduk was. But this would again be fatal—for in that case it would not be the first act of Elohim!

[2] ויבדל אלהים בין האור ובין החשך (!)

From the analogy above given it will be seen that "man" or the "creation of man," if we take our stand on the account of Gen. i., cannot be referred either to one or to the other side, i. e., we do not know whether he was a descendant of the "waters above the firmament" or of "the waters below the firmament," from which latter the "earth" and its "creatures" took their origin. All we learn is this: "man was created in the image and likeness of Elohim"—a ἐν διὰ δυοῖν, which tells us that man looks exactly like Elohim.[1] The Babylonian account tells us that man was made out of divine blood mixed with earth. The writer of Gen. i. with his monotheistic idea could, of course, never admit that the "blood of another god" was spilt—because there existed no other god. But he apparently accepted the idea that man was in some way or another connected with the gods, hence he made him to be created in the image and likeness of Elohim. The account given in the second chapter of Genesis has, however, for "image and likeness" the "breathing into man's nostrils the breath of life," which was done by Jahveh. In blood there is life, and life is a breath,—was the faith of the Jahvistic writer. Accordingly he substituted for the blood of God the "breath of God," thus connecting "man" again with his creator.

We have seen then that the fight of the light against the darkness does not belong originally to the account of Gen. 1. But, one may rightfully ask, if it does not, how are the apparent indications of such a fight to be found in Gen. 1 to be explained? To answer this question it will be necessary for us to examine the Babylonian account of the creation and see whether the original form of that account contained the fight of Marduk with Tiâmat or not.

That the Babylonian creation story had its development and required time to assume the shape in which we now know it, is of course self-evident. If we are able to trace the different threads in the development of the Hebrew literature by employing critical

[1] Comp. here Gudea's dream where ^{dingir} Nin-Gir-su is said "to be a man," i, e., where a god is said to look "like a man."—This, no doubt, is the older conception: gods always look like the men to whose tribe or nation they belong. See below.

methods, I think we ought to be able also to trace the threads,—delicate and flimsy though they are,—which the inscriptions of early Babylonia put into our hands. In the following then I shall try to show that even the Babylonian creation story did not *originally* contain such a myth as the fight of Marduk with Tiâmat.

* * *

We have now to crave the reader's indulgence for a rather technical discussion of a few points which at first sight may seem indifferent; but this course of procedure is indispensable for an analysis of the creation-story of Genesis. Having established the genealogical order of the Babylonian divinities, we shall be better able to understand the kinship between the Hebrew Genesis and the Sumerian cosmogony.

Before entering on our investigation, it is necessary to say a few words about the meaning of NIN, EN, LUGAL, and DINGIR.

In the "trilingual list of gods," II R 59, we read in Col I, l. 48:

^{dingir}MUL DIN-TIR-^{ki} | ^{dingir}NIN-DIN-TIR-^{ki} | ^{dingir}AMAR-UD

The ^{dingir}AMAR-UD is Marduk. Marduk was the city-god of Babylon. But—and this is important—he is not called in the "Sumerian" column EN but NIN. This NIN is rightly transcribed in the EME-SAL column by U, i. e., MUL or UMUN = lord. Hence NIN must mean here = bêlu or "lord." This does not prove that Marduk as the city-god of Babylon became a "feminine." He retained his gender and remained a male deity, for in the same list, Col. II, l. 17, we read:

^{dingir}MUL (fem.!) DIN-TIR-^{ki} | ^{dingir}NIN-DIN-TIR-^{ki} | ^{ilu}Be-lit ^{alu}Bâb-ilu-^{ki}!

NIN, then, in this connection, i. e., when used with the name of a city,[1] may stand either for bêlu or bêltu, i. e., for *his* lordship,

[1] Forming with the name of the city a "proper name" as in ^{dingir}Nin-Gir-su or standing in apposition as in K. B. III[1]. pp. 24, 46. ^{dingir}Dumu-zi-zu-ab, nin Ki-nu-nir-^{ki}!!

or *her* lordship. In most cases we will be able to determine exactly the gender either from the syllabaries or from the "apposition" that may follow such a name, as for instance, ^{dingir}NIN-EN-LIL-^{ki} is explained in the very same list by "the wife of Ninib."

The ^{dingir}NIN-GIR-SU. is called in the oldest Babylonian inscriptions the ur-sag or ur-sag lig-ga, "the mighty prime minister" of Bêl,—hence the city-god of Gir-su must have been a male divinity. It is indeed strange that male gods, when becoming gods of certain cities, should be called NIN; we should expect of course for NIN either EN or LUGAL. EN—as far as I know—is never used in this connection, but only LUGAL, see, e. g., the name ^{dingir}LUGAL-ERIM-^{ki}. The EME-SAL texts distinguish clearly between the gender by using two different signs, but not so the Sumerian of the lists or bilingual inscriptions,—and also not the old Sumerian. This latter, when intending to make the gender absolutely certain, uses for NIN the word LUGAL. LUGAL then always denotes a male, while NIN may stand either for a male or a female divinity. What may possibly be the reason for the use of this NIN?

We know that in Babylonia every city had its *special god.* As long as the city was in possession of her patron she enjoyed independence. But in case the "god left the city," or "went out of the city," i. e., when the god was carried away captive by a victorious king, the city lost her independence. The city-god, then, was something which had to be defended and protected, which had to be fostered and cared for, but which could also be "taken," either by force, inclination, or otherwise, which could be chosen, betrayed or given away, which could be sold,—all characteristics of a woman! Even we are in the habit of personifying our nations as feminine; note, for example: Helvetia, Bavaria, Borussia, Germania, Britannia, and Columbia!

From this also follows that a name like ^{dingir}Nin-Gir-su is no proper name but a surname or attribute. This is even grammatically indicated in the oldest inscription, for we find very often after the name ^{dingir}Nin-Gir-su the double postposition KA-GE. In this re-

spect Galet A of Eannatum[1] is especially interesting. Compare, e. g., such expressions as these:

"Eannatum....à-sum-ma dingir Nin-Gir-su-ka-ge, i. e., Eannatum....to whom power was given by (ge) the lord of (ka) Girsu."[2]

Such surnames or attributes of gods are very common, yes, we may rightly say that all the names of the gods we know are really not proper names at all, but attributes or appellatives.

To establish this, I may be allowed to cite a few more examples.

The name dingir Innanna cannot be a proper name, for we find the *double* postposition after it. If it were a proper name, only *one* postposition would be expected.

"Eannatum....mu-shag-sa-a dingir Innanna-ka-ge."[3]
Eannatum....dam ki-ag dingir Innanna-ka-ge.[4]"

Hence we cannot translate the inscription of Lugaltarsi otherwise than has been done in E. B. H. p. 125$_3$, viz.: For the king of the lands (= Bêl) and for Innanna, the mistress of the divine Innanna, etc.

Among other names for "gods" which are used with a double postposition may be mentioned: dingir Nin-char-sag,[5] dingir Dumu-zi-zu-ab,[6] dingir Pa-sag,[7] gal + (ga)lu + dingir Erim,[8] and even dingir En-ki,[9] etc., etc.

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[1] See my *Early Babylonian History* (afterwards to be referred to as E. B. H.), p. 83 ff.

[2] For other examples see *ibid.*, col. VII, 9; V, 1; VI, 16; VII, 16 Cône of Entemena = E. B. H. p. 97 ff., col. V, 5 *et passim*.

[3] E. B. H. p. 84: Eannatum....who was called by the heart of the goddess of Innanna.

[4] Déc 3 B^1, col. II, 9: "Eannatum....the beloved husband of the goddess of Innanna. Thus it has to be translated! In this passage it is preceded by: Eannatum ....ku-li ki-ag dingir Gal + galu-Erim,—both sentences have to be separated on account of the parallelism. If we do not, then Lugal-Erim would become the dam-ki-ag of Innanna. That kings often *do* call themselves a "dam" or husband of a certain goddess is evident from E. B. H. pp. 230, 231, and notes.

[5] Galet A = E. B. H. p. 84, col. II. 3; comp. Déc. XLIV., col. IV. 10.

[6] *L. c.*, col. II, 9. [7] *L. c.*, p. 85, l. 11. [8] *L. c.*, l. 13.

[9] *L. c.*, p. 84, l. 7. dingir En-ki becomes thus the divine EN of KI. According to this analogy we ought to expect also, *l. c.* Col. I. l. 6, for mu-pad-da dingir En-

Not only, however, before the names of cities may NIN stand for bêlu. There are quite a good many "names of gods" composed with NIN, which can signify male gods only. In the composition of these names the NIN seems to mean as much as "possessor of" = Arabic dhû, dhât. To this class belong, among others, the following: ^{dingir}Nin-à-gal,[1] ^{dingir}Nin-dar-a lugal-en,[2] ^{dingir}Nin-gish-zi-da,[3] ^{dingir}Nin-gir,[4] Nin-dub lugal-en,[5] ^{dingir}Nin-sar gir-lal ^{dingir}Nin-Gir-su.[6]

If in this way NIN *may stand* for bêlu as well as for bêltu, we have, in order to determine the gender of the gods, whose names are compounded with NIN, to pay great attention to the titles or other attributes which may or may not follow. They will show us in most cases whether the god in question is either a male or a female.

The titles or attributes stand almost always in apposition, i. e., they *follow*[7] the name of the god. In these appositions we have to distinguish between:

(1) LULAL or EN and NIN on the one hand and;

(2) LUGAL and NIN on the other.

With regard to (1) as well as (2) the following examples may suffice:

Ur-Gur[8] dedicates an inscription to ^{dingir}En-lil, lugal-kur-kur-ra lugal-a-ni, i. e., to Bêl, king of the lands, his king. "The king of

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lil-ge = ^{dingir}En-lil-ka-ge. En-lil, however, I have not yet found with a double postposition.

[1] K. B. III[1]. p. 20: "the possessor of great power," whom Jensen, *l. c.*, p. 21, note *, takes according to II. R. 58, 58, to be "Ea als Gott der Schmiedekunst." K. B. III[1]. p. 24. E. B. H. 182, 185.

[2] K. B. III[1]. pp. 24, 28, 46, and E. B. H. 182_1, *et passim*.

[3] K. B. III[1]. pp. 28, 46, "the possessor of the tree of life."

[4] "The possessor of the gir," see below.

[5] I. R. 5. XXIII. Gudea Cyl. A VI. 5, "the possessor of the tablet."

[6] E. B. H. pp. 52, 54 (corrected! see below, p. 590, 6).

[7] Exceptions where the attributes precede the names are rare, but they occur. Comp., e. g., en ^{dingir}Nin-Gir-su "the lord Nin-Gir-su in Gudea Cyl. A. and B. pass. "Am Shir-pur-la-^{ki} azag ^{dingir}Ga-tum-dug" "the mother of Shirpurla, the glorious Gatumdug," Gudea, Statue B. VIII, 56, K. B. III[1]. p. 46. dingir-ra-mu ^{dingir}Nin-gish-zi-da "my god N." *l. c.*, col. IX., 4, and probably a few more.

[8] E. B. H. p. 222. For other examples, see E. B. H. *passim* and K. B. III.[1] p. 74–78.

the lands" and Ur-Gur's "king" is Bêl by virtue of his being a god. The former is his *attribute*, the *latter* expresses his *relation* to Ur-Gur. Rim-Sin[1] dedicates an inscription to ^{dingir}Nin-shach en-gal-lal . . . . lugal-a-ni-ir. The "en-gal-lal" expresses that which Nin-shach is by virtue of his being a god, the lugal-a-ni-ir expresses the relation in which he stands to Rim-Sin.

From these two observations we may draw the following rule:

Every *male god* when brought into relation to men (kings, or others who dedicate) is ALWAYS a LUGAL or "king," but by virtue of his being a god, he may be either a "LUGAL or king" or an "EN or lord." Every goddess, however, is by virtue of her being a goddess[2] as well as when brought into relation to men *always* a NIN[3] or "mistress." No. (1) expresses the titles of gods *as* gods. No. (2) expresses the *relation* of gods *to men!*

If this observation be true we may lay down another rule: NIN when in *apposition* indicates ALWAYS a *female* god, or goddess.[4] Thus there ought to correspond, e. g., to a LUGAL-EN a NIN-EN. Indeed we find this to be true! The ^{dingir}Nin-dar-a[5] is called LUGAL-EN[6], while ^{dingir}Ninâ has the apposition NIN-EN[7] or NIN-EN-NA.[8]

We have seen above that even the name ^{dingir}EN-KI must be composed of two separate names on account of the double post-position which it may suffer behind it. The ^{dingir}EN-KI is as the EN indicates a *male god*, hence is followed also by LUGAL[9] in

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[1] I. R. 3 No. X = K. B. III[1]. p. 94, 3. For a similar case see IV. R. 35 No. 6 = K. B. III[1]. p. 96, 6.

[2] See below the attributes of the wife of En-lil.

[3] E. B. H. p. 125. 222 *et passim*.

[4] EXCEPT when NIN stands *before* the name of a CITY or place! See p. 578, 1. ^{dingir}Dumu-zi-zu-ab NIN Ki-ǹu-nir-^{ki}, in this case NIN may be *doubtful!* Further attributes or the name itself of the god must explain the gender in this case!

[5] Also read ^{dingir}Nin-si-a.

[6] E. B. H. p. 193. K. B. III[1]. p. 24. Lugal-en probably = the "lord of the priests," i. e., "the highpriest."

[7] E. B. H. pp. 193, 224, note 4, Nin-en probably = "the mistress of the priests," i. e., "the highpriestess."

[8] E. B. H. p. 87 note.

[9] See, e. g., lugal zu-ab, Déc. 4 B[2], col. IV, 3.

apposition. The counterpart of ^{dingir}EN-KI is ^{dingir}NIN-KI, which name is also to be found in the Earliest Babylonian Inscriptions.[1]

Here, then, we have *another* peculiarity. We do not find LUGAL + X for the male god, as we might expect, but ALWAYS EN. "EN" in such names as ^{dingir}EN-KI indicates the *masculine*, while "NIN" indicates the *feminine* gender. What may be the reason for THIS peculiarity? The answer is: male or masculine gods are LUGAL = king from the standpoint of men to whom kings, of course, also belong, but EN, when compared with their equals, their wives, i. e., "the husband-god" and the "wife-god," are on the same level considered by themselves, but when brought into relation with *men* the "husband-god" seems to enjoy a greater prerogative; nay, the kings considered themselves equal to a goddess, hence they sometimes called themselves the "dam" or husband of this or that goddess.[2]

To the same class with ^{dingir}EN-KI belong among others also ^{dingir}EN-LIL, ^{dingir}EN-ZU,[3] ^{dingir}EN-GUR,[4] ^{dingir}EN-Ba-u,[4] etc., etc. In all these names the "EN" corresponds to our "husband," or "Mr." If NIN were substituted for EN, we should have the "wife" or "Mrs."—hence the real proper name of ^{dingir}EN-KI would be ^{dingir}KI; the EN or NIN having been put before the KI in order to distinguish the "*husband*" from the "*wife*," or the "Mr." from the "Mrs."[5] In course of time these names came to be looked upon as *real* proper names, and only now and then does their grammatical construction betray to us the true fact, i. e., that

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[1] E. B. H. p. 81, note 1.

[2] See above, p. 580, 4. This fact also probably contributed somewhat to the "divine character" of the kings.

[3] See E. B. H. Index, gods, p. 443 sub E.

[4] So far not found in the oldest inscriptions. Thureau-Dangin in C. R. 1902, Janvier, p. 82, note 2, proposes to read the sign GUR = Engur, referring to C. T. XII. 38128, Rev. l. 18 compared with II. R. 58, 53*a*.

[5] Thus it happened that in course of time the deity was *differentiated*, i. e., the deity was originally a self-perpetuating being, a kind of androgyn, and later on was separated or thought to exist as "husband" and "wife." Comp. the ^{dingir}GUR, ^{dingir}EN-GUR, ^{dingir}NIN-GUR and also Gen. ii. 21, where Eve is said to have been made "from one of the ribs," i. e., better "sides" of Adam.

they are names composed out of EN resp. NIN + the *real name* of the god.

The last point which we have to discuss is the use of the name DINGIR or "god." The oldest Babylonian inscriptions are *always very careful* to put the ^{dingir}-sign before the name of a god.[1] The names for god Anu[2] and Gu-la[3] are probably the only ones which generally occur without the dingir-sign.[4]

The negligence in omitting the sign *dingir* before the names of gods begins at the time of the first dynasty of Babylon. Above we have seen that every city had its god. Not only the cities, however, but also the different kings and patesis (priest-kings) had their favored deities whom they termed *dingir*,—while the others were either LUGAL or NIN. The *god* of Urukagina was ^{dingir} Nin-shullil,[5] that of Eannatum,[6] and Entemena:[7]

^{dingir} Dun-gur[8] or also written ^{dingir} Dun-gur-an;[9]

^{dingir} Nin-à-gal[10] is the god of Ur-Ba-u;

^{dingir} Nin-gish-zi-da[11] that of Gudea;

^{dingir} Lugal-banda[12] that of Sin-gâshid, etc., etc.

If cities and kings and patesis had their special gods, it is more than probable that also the "lands" and "countries," the "families" and "tribes," in fact, every "person," had his own

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[1] Except when the name of a god occurs in a name of a city: e. g., EN-LIL-^{ki} = Nippur, for ^{dingir} EN-LIL-^{ki}. But see E. B. H., Index, Gods.

[2] In the Old Babylonian inscriptions the god Anu is mostly written AN-NA, but also AN-E (Gudea, Statue B, VIII. 45 = K. B. III^{1}. p. 46), An-nu-um, ^{ilu} An-nu-um, and ^{dingir} AN occur, see E. B. H, Index, Gods, p. 442. Here also belongs, of course, his wife An-nat.

[3] See E. B. H. p. 443.

[4] ^{dingir} Ba-u, when in proper names and written "Ba-bi," has never the sign of dingir.

[5] E. B. H. p. 51.

[6] E. B. H. p. 92.

[7] E. B. H. p. 108. K. B. III^{1}. p. 72.

[8] E. B. H. p. 92.

[9] E. B. H. pp. 115, 116, 118.

[10] Ur-Ba-u V. 4, 5 = K. B. III^{1}. p. 24.

[11] E. B. H. pp. 196, 199, 207. K. B. III^{1}. pp. 28, 46 (= Statue B, III. 4, 5. IX. 4). Cyl. A. XVIII. 15 *et passim*.

[12] K. B. III^{1}. p. 84. Lugal-banda is the husband of Nin-sun, who again is the mother of Nin-gish-zi-da (Cyl. B. 23, 5", 6"), and this latter is said to be a dumu-ka An-na-kam (Cyl. B. l. c.). For dumu-ka = "descendant," see E. B. H. pp. 14, 15.

special god. The inscriptions so far accessible to scholars do not shed much light upon this question, yet there are at least one or two examples that countries had their special gods: ^{dingir}Mar-tu, "the god of the Westland," i. e., of the Ammorites.[1] In the old Babylonian inscriptions, Babylonia, when spoken of in its totality, i. e., when South and North Babylonia are meant, is called:

Ki-en-gi-ki-Urdu (BUR-BUR).

A ^{dingir}Urdu (BUR-BUR)-zi occurs in an inscription of Ninkagina[2] and in Cyl. B of Gudea.[3] The ZI in the name of this god is, no doubt, the same as that in the name ^{dingir}EN-LIL-ZI, which latter name is explained by nu-banda (?) ^{ilu}Bêl (EN-LIL),[4] i. e., "the servant of Bêl." The ^{dingir}Urdu-zi then is the "servant" of "god Urdu," and as ^{dingir}EN-LIL is the city-god of Nippur, so probably is ^{dingir}Urdu the country-god of Urdu (BUR-BUR), which latter again with "KI" or "place" sign before or after it, signifies the country "Akkad." In like manner, we might explain Ki-en-gi as the land (KI) of EN-GI—and EN-GI being = "husband" or "Mr." GI—we should have here another god of a country, viz., that of Shumer.[5]

The results of our investigation so far would be as follows:

NIN before or in composition with the names of cities and deified attributes may stand either for a male or female god,—the context or syllabaries or other texts must be taken in to decide the gender of each respective god.

LUGAL before or in composition with the names of cities or deified attributes stands always for a male divinity.

NIN in apposition or as attribute of a divinity always shows that that divinity is *feminine*; if it be masculine the word LUGAL or EN is used.

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[1] E. B. H. p. 411. Here belong, of course, the deified attributes ^{dingir}Lugal-kur-kur-ra, ^{dingir}Nin-char-sag, etc.

[2] E. B. H. p. 186. [3] Cyl. B. IX. 13. [4] II. R. 59 col. I. 20.

[5] If my explanation of Shumer = Gir-su (see E. B. H. p. 216 ff.) be correct, the ^{dingir}Nin-Gir-su, the surname, would stand for the god GI or better for ^{dingir}EN-GI. Such a ^{dingir}EN-GI seems to occur in IV. R. 35 No. 6 = K. B. III^{1}. p. 96. 6.

NIN and EN in proper names for gods correspond to our "Mr." and "Mrs." The real name of the god being always expressed by the sign that follows the Nin or EN respectively.

Bearing this in mind, we may now consider the names of the different gods themselves.

1. The god LIL.

Mr. LIL, according to our rules laid down above, would have to be called ^{dingir}EN-LIL and Mrs. LIL, ^{dingir}NIN-LIL—both occur in the oldest inscriptions.[1] ^{dingir}EN-LIL is called lugal-kur-kur.[2] This attribute has become in course of time even a proper name, to which the sign *dingir* was prefixed: ^{dingir}Lugal-kur-kur.[3] If EN-LIL was a lugal-kur-kur, then his wife must have been a nin-kur-kur; this would follow from the analogy of the case! So far I have not yet seen an inscription where NIN-LIL is called nin-kur-kur, but EN-LIL is called also lugal-an-ki,[4] and NIN-LIL nin-an-ki.[5] Not only NIN-LIL is the "mistress of heaven and earth" but also ^{dingir}Nin-char-sag.[6] This latter goddess is also called am dingir-ri-ne[7] and am tur-tur-ne,[8] while ^{dingir}En-lil has the title: ab-ba din-gir-dingir-ru-ne,[9] and is the same as the ^{dingir}Lugal-dingir-e-ne.[10]

Am dingir-ri-ne is also the attribute of ^{dingir}Nin-tu.[11] ^{dingir}Sal (var. NIN)-in-si-na[12] is called am kalam-ma zi-gàl kalam gim-

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[1] For the different writings and for references see E. B. H. Index, gods, sub. E. and N., pp. 443 and 445.

[2] "King of the lands," E. B. H. pp. 131, 134, 151 *et passim*.

[3] E. B. H. p. 125, note 3; p. 132, l. 14.

[4] "King of heaven and earth," Stele of Vultures, London 23580, col. II. 10.

[5] "Mistress of heaven and earth," E. B. H. p. 125, note 1.

[6] E. B. H. p. 199 and note 5.

[7] "Mother of the gods," Ur-Ba-u III. 8 = K. B. III[1]. p. 22.

[8] "Mother of the children," E. B. H. p. 198 and note I. 3.

[9] E. B. H. p. 97, "father of the gods," cp. the a-bu ilâni banû in Shalm. II. Obelisk l. 4.

[10] IV. R. 35_1 = K. B. III[1]. p. 78, "the king of the gods."

[11] E. B. H. p. 199, and note 5.

[12] See also ^{dingir}Innanna ^{dingir}Nin-an (sic! not dingir)-si-an-na E. B. H. p. 273.

gim-me[1] and dumu-sag an-azag-ga.[2] This latter title she has in common with dingir Ba-u,[3] who again is called dumu AN-NA[4] or dumu-sag AN-NA[5], but also dingir Ga-tum-dug is called dumu an-azag-gi tu-da.[6] dingir Ba-u[7] as well as dingir Ga-tum-dug[8] are called am Shir-pur-la-ki, i. e., "mother of Lagash," the former is also known under the name Nin-an-da-gal-ki,[9] as such again she is identical with dingir Nin-char-sag![10] EN-LIL was called lugal-kur-kur, and the nin-kur-kur is dingir Innanna.[11] Especially interesting is the dingir Innanna nin-char-sag[12]—this latter attribute being made later on a proper name, thus becoming dingir Nin-char-sag! Other attributes of dingir Innanna are: nin mè[13] and nin azag-nun-na.[14]

Sometimes dingir Nin-lil,[15] or dingir Innanna,[16] or dingir Nin-char-sag[17] is coupled with dingir En-lil. From all this it follows that the above given goddesses were originally the same as "Mrs." Lil or NIN-

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[1] "Mother of the world (or people), who created the creatures of the world," E. B. H. p. 202, note I. 1.

[2] E. B. H. p. 202, note I. 1: "the firstborn of An-azag-ga, i. e., the glorious AN."

[3] E. E. H. p. 209: Gudea, Statue H. col. I. 6.

[4] E. B. H. *l. c.* col. I. 3. Gudea, Statue G. col. II. 5 = K. B. III[1]. p. 58, 'child of AN-NA."

[5] Gudea, St. B. VIII. 59 = K. B. III[1]. p. 46, Cyl. A. XX. 19.

[6] Gudea, Cyl. A. II. 27 = Thureau-Dangin, Le songe de Goudéa, p. 6, "child born of the glorious AN.

[7] E. B. H. p. 21. But see also Déc. p. XXXIII. and Revue archéol, 1886, pl. VII. No. 1.

[8] Gudea, Statue B. VIII. 56, 57 = K. B. III[1]. p. 46.

[9] "Mistress of the wide heaven and earth," E. B. H. 206, and note 12.

[10] See above, p. 586, 6.

[11] "Mistress of the lands," E. B. H. p. 199 = Gudea, Statue C. col. II. 2, and p. 201, col. IV. 10.

[12] P. S. B. A. XIII. 159 = K. B. III[1]. p. 98 (Rim-Sin): "Innanna the mistress of the mountain."

[13] "Mistress of battle," Gudea, St. B. VIII. 61.

[14] "The glorious exalted mistress," Ur-Ba-u IV. 8. Jensen, K. B. III[1]. p. 22.

[15] E. B. H. p. 125, note 1.

[16] E. B. H. p. 125, note 2: here after dingir Lugal-kur-kur, which is here, as was shown above, p. 586, 3, a name for dingir EN-LIL.

[17] Gudea, Statue B. VIII. 47 = K. B. III[1]. p. 46.

LIL, who is expressly called the dam ^{dingir}En-lil.[1] They represent NIN-LIL in her different capacities and are "deified" attributes of the wife of LIL. Such a "deification" of attributes seems to have been almost endless and began at the very earliest times of Babylonian history.

Not only, however, the attributes contributed greatly to the multiplicity of a single god or goddess, but also the places where such a god or goddess might be worshipped. Thus we have a ^{dingir}Innanna-edin,[2] a ^{dingir}Innanna-Erin-^{ki} (= the goddess of Susa), and in later times the Ishtar of Arba-ilu, of Ninâ, and Kidmuri. There seem to have been even different EN-LILs, as is apparent from such expressions as ^{dingir}En-lil En-lil-^{ki}-a[3] "the Nippurian Enlil or Bêl" in contradistinction to *another* Bêl. ^{dingir}Ba-u, another name[4] for ^{dingir}Nin-lil, the wife of EN-LIL, is the dumu or sometimes also the dumu-sag of AN-NA, i. e., the "child" or "firstborn child" of AN-NA.[5]

What was the name of the father of EN-LIL? The old Babylonian inscriptions do not give an answer to this question, but from Assyrian inscriptions we know that Bêl (the Semitic Babylonian for EN-LIL) was called the mâr rêshtû shamê, i. e., "the firstborn child of heaven." The Assyrian shamê translates the Sumerian AN or AN-NA, hence it follows also EN-LIL was the firstborn of AN. This is important: ^{dingir}Ba-u as well as ^{dingir}En-lil are a FIRSTBORN; both are *brother* and *sister* but at the same time *husband* and *wife!*

(2) The children of EN-LIL.

(*a*) The god ZU.

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[1] "The wife of Enlil," E. B. H. p. 125_1.

[2] See E. B. H. Index, gods.

[3] E. B. H. p. 272 *et passim*.

[4] On account of the writing "Ba-bi," see the proper name Ur-Ba-bi and the E-Ba-bi in E. B. H. pp. 237, 326, and 365. I consider "Ba-u" to be a *Semitic* name. In later inscriptions occurs also the writing ^{dingir}Ba-bur. Ba-bi = genitive, and Ba-bur = dative (sic!) is in *Sumerian* impossible. Ba-bur is formed in Semitic *and* Sumerian fashion, as the r (= ra or ru) shows. In good Sumerian the postposition "ra" is shortened to r only after i as in ni, cp: dingir-ra-ni-ir, lugal-a-ni-ir! This ^{dingir}Ba-u has of course nothing to do with the בהו in Gen. i. 2.

[5] See above, p. 587, 4. 5.

Mr. ZU is EN-ZU[1] and Mrs. ZU is NIN-ZU. The latter is known to me only from the proper name Ur-^{dingir}Nin-zu, "the servant of NIN-ZU."[2] Another, *later*, name[3] for EN-ZU was ^{dingir}Uru,[4] or mostly written ^{dingir}Uru-ki.[4]

This ^{dingir}Uru-ki is the dumu-sag ^{dingir}En-lil-lal.[5] Under the name ^{dingir}En-zu he is known also as the amar-banda ^{dingir}En-lil[6] and as ^{dingir}Uru-ki as the amar-banda An-na.[7] The wife of ^{dingir}Uru-ki is also called ^{dingir}Nin-gal.[8] Uru-ki or En-zu had several children:

α. ^{dingir}UD,[9] who is called "sib tu-da ^{dingir}Uru-ki."[10] The wife ^{dingir}A-A of ^{dingir}UD is so far not found in Old Babylonian texts.

β. ^{dingir}Innanna nin char-sag . . . TUR-SAL ^{dingir}EN-ZU-NA.[11]

With ^{dingir}UD probably is closely connected the ^{dingir}AMAR-UD, i. e., "the ox of UD,"[12] or "the child of UD."[13] This god does not[14] occur in the oldest inscription. He is known to us

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[1] For the inscriptions in which he occurs see E. B. H., Index, gods, p. 443 sub E.

[2] E. B. H. 412, $_1$. To read Nin-a-zu for Nin-zu is not necessary, for we know from later inscriptions that EN-ZU had a *wife*, and if he had, her real or original name *must* have been ^{dingir}Nin-zu.

[3] Which was originally an attribute of EN-ZU.

[4] See E. B. H., Index, gods, p. 445 sub U. The ki at the end probably is only the prolongation syllable. Comp. also Uru-nung-^{ki}-ma, not Uru-ki-nung-^{ki}ma.

[5] "The firstborn of Enlil." 1 R. 1 No. I. 4 (K. B. III^1. p. 76 No. 3), 1 R. 1 No. I. 5 (K. B. III^1. p. 78. $_4$). 1 R. 5 No. XX (K. B. III^1. p. 92, l. 21).

[6] Déc. 4 B^2. V. 1, "the strong ox = puru iqdu, rêmu iqdu of En-lil.

[7] 1 R. 1 No. I. 4 = K. B. III^1. p. 76, $_8$.

[8] "The great mistress," 1 R. 2, No. VI, 1 (K. B. III^1. p. 86, $_1$); 1 R 2, No. IV (K. B. III^1. p. 90, *d*).

[9] Generally read ^{dingir}Utu.

[10] "The shepherd, born by Uru-ki." 1 R. 2, No. VI. 1 (K. B. III^1. p. 86, $_1$.)

[11] "Innanna, the mistress of the mountain . . . . the daughter of ^{dingir}En-zu, P. S. B. A. XIII. 159 (K. B. III^1. 98). Comp. also Ishtar's descent, IV. R. 31, $_2$ (K. B. VI. 81): ^{ilu}Ishtar TUR-SAL ^{ilu}Sin. For the writing EN-ZU-NA for EN-ZU, see also E. B. H. p. 317, $_1$: ^{dingir}Ur-^{dingir}En-zu-na.

[12] Comp. the "amar banda" above, note 6.

[13] Comp. the proper name ^{dingir}AMAR ^{dingir}EN-ZU = Bur-Sin II., King of Ur, E. B. H. p. 266, note 2. According to the analogy of this name AMAR-UD might also be translated by "an ox is UD or Shamash."

[14] The cities Tu-tu-^{ki} (E. B. H. p. 174), Su-kur-ru-^{ki} (E. B. H. p. 302. xi) do not prove anything. OBI No. 87. I. 30 is ^{dingir}UMU and not ^{dingir}SHID (E. B. H. p.

only since the time of the first dynasty of Babylon, about 2400 B. C.

In this line somewhere belongs also Nin-gish-zi-da, Lugal-banda, and Nin-sun, see above p. 584, 12.

b. Another child of ^{dingir}En-lil is ^{dingir}Nin-Gir-su,[1] the city-god of Girsu. How this god was originally called, or what his real name was, we do not know as yet.[2] He is a male divinity.[3] The wife of ^{dingir}Nin-Gir-su was ^{dingir}Ba-u.[4] A sister of ^{dingir}Nin-Gir-su is ^{dingir}Ninâ.[5] The dumu-ush–7 ^{dingir}Ba-u-me banda en ^{dingir}Nin-Gir-su-ka-me[6] are hardly the sons of En-lil and Ba-u but of Nin-Gir-su

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133). Su-kur-ru-^{ki} should be read according to Br. Mus. 82–8–16, $_1$, l. 45: Shu-ru-up-pak. Tu-tu-^{ki} had probably also another pronunciation. Strange, very strange, is that Bur-Sin II., whose name is written ^{dingir}AMAR ^{dingir}EN-ZU, should be worshipped after his death as the MUL-AMAR-UD (E. B. H. p. 316). He, being while alive a "child of Sin," becomes sometime after his death a "child of Shamash"!

[1] Cyl. A of Gudea, col. VII. 5: ^{dingir}Nin-gir-su dumu ^{dingir}En-lil-lal-ka. *Ibid.*, VIII. 21: dumu ^{dingir}En-lil-lal en ^{dingir}Nin-Gir-su, cp. also *ibid.* IX. 3.

[2] See, however, above, p. 585. [3] See above, p. 579.

[4] ^{dingir}Nin-Gir-su-ge ^{dingir}Ba-u dumu An-na dam ki-ag-ga-ni. Gudea, Statue G, col. II. 3 ff. (K. B. III[1]. p. 58). This ^{dingir}Ba-u is of course the same as the ^{dingir}Ba-u the wife of ^{dingir}En-lil.

[5] See below sub "god KI."

[6] "The 7 sons of Ba-u the banda of lord Nin-Gir-su." Gudea, Cyl. B. XI. 11, 12. The sign ush after dumu is not quite clear. The 7 is plainly written. According to my transcription which I made from Price's text, there seem to be mentioned only 6 sons. Where is the seventh? The six mentioned are the following (l. l. 4–10):

l. 4. ^{dingir}Za-za-ru.
5. ^{dingir}Im-pa-ud-du.
6. úr (= ishdu)-kalam-ta-ud-du-a.
7. ^{dingir}Ghe(GAN)-gir-nun-na.
8. ^{dingir}Ghe(GAN)-shag-ga.
9. ^{dingir}Ka-úr(= ishdu)-mu.
10. ^{dingir}Za-ar-mu.

Uru-ka-gi-na in his Barrel-Cylinder, E. B. H. p. 53, mentions also the following gods: II. 10. ^{dingir}Za-za-ru, 11. ^{dingir}Im-pa-ud-du, 12. ^{dingir}Gim-nun-ta-ud-du-a. 14. ^{dingir}Nin-sar gir-lal ^{dingir}Nin-Gir-su (so read also E. B. H, p. 52, l. 23, where Nin-sar is mentioned too, and comp. for this reading Déc. p. XLIX, copie de F. Thureau-Dangin). There can hardly be any doubt that ^{dingir}Gim-nun-ta-ud-du-a is = úr-kalam-ta-ud-du-a, hence we ought to read above l. 6 = ^{dingir}Ur-kalam-ta-ud-du-a. For the formation of the name comp. ^{dingir}E-SHIT-LAM-ta-ud-du-a = Nergal.

and Ba-u. A child of dingir Nin-Gir-su was also called dingir Dun-shag-ga.[1] He must be a male god, because Gudea dedicates the inscription to him as his "KING."[2] He probably is the same as the dingir Ghe(GAN)-shag-ga.[3] Another child of Nin-Gir-su was dingir Gàl-alim dumu ki-ag-ga-ni en dingir Nin-Gir-su.[4]

3. The god AN.

According to our principle laid down above, "Mr." AN[5] would be called EN-AN and Mrs. AN NIN-AN. The EN-AN occurs so far only in proper names, as e. g., EN-AN-NA-tum.[6] NIN-AN is not found at all. That there indeed existed a "Mr." and a "Mrs." AN is evident from the Semitic Inscription of An-nu-ba-ni-ni, where they are called An-nu-um and An-nat respectively.[7] At the time of the fourth dynasty of Ur the eleventh month was sacred to him, which month was therefore called "the month of the festival of An-na."[8] He was the father of EN-LIL.[9] But who was the father of AN? Before we answer this question, we shall have to consider the god KI.

4. The god KI.

Mr. KI again is EN-KI and Mrs. KI NIN-KI. Both names occur already in the oldest inscriptions.[10] Another name of Mrs. KI was dingir Dam-gal-nun-na,[11] i. e., "the great wife of Nun." From

[1] E. B. H. p. 195, 196: dingir Dun-shag-ga dumu ki-ag dingir Nin-Gir-su-ka lugal-a-ni Gudea.

[2] See above, p. 585. [3] See preceding page, note 6.

[4] Gudea Cyl. B. VI. 22: "Gàl-alim his beloved child of Nin-Gir-su." See also Statue B. II. 18, 19 (K. B. III[1]. p. 28), and E. B. H. pp. 49, 51. He is mentioned by Uru-ka-gi-na in the same inscriptions in which the other sons of Nin-Gir-su occur!

[5] For the different writings see above, p. 584, 2.

[6] See E. B. H., Index, proper names, p. 436 sub E.

[7] E. B. H. p. 177.

[8] E. B. H. pp. 296, 299, 302: Itu Ezen An-na.

[9] See above, p. 588.

[10] For EN-KI see E. B. H. Index, gods, p. 443 sub. E., and for NIN-KI E. B. H. p. 81, note 1. The later writing dingir EN-KI-ga with an unknown pronunciation (Jensen, K. B. III[1]. p. 21, note †) I have not yet found in the oldest texts. Comp. here, however, the name: NUN-^{ki} = Urudug-^{ki} or Eridug-^{ki} = Eridu.

[11] E. B. H. p 224. In the later Assyrian texts dingir Dam-gal-nun-na became Damkina. II. R. 55, 53. 54d (comp. l. 16): (Ea) Dam-ki-na ashshati-shu.

this it follows, that EN-KI had also the name NUN, or else NIN-KI could not have been called "the great wife of NUN." EN-KI is called lugal zu-ab.[1] This would presuppose a title "nin zu-ab" for NIN-KI; I have, however, not yet found this latter title for Mrs. KI. And because EN-KI is the lugal zu-ab it is probable that the ^{dingir}Dumu-zi-zu-ab,[2] also shortened to ^{dingir}Dumu-zi,[2] was a son of EN-KI. Of the ^{dingir}Dumu-zi the later ^{ilu}Tammuz is no doubt a simple contraction.[3] To ^{dingir}Dumu-zi was dedicated at the time of Sargon I. and later on also at the time of the fourth dynasty of Ur, the *sixth*[4] month, which was called "the festival of ^{dingir}Dumu-zi."[5] A daughter of EN-KI (hence also a brother of ^{dingir}Dumu-zi-zu-ab) was ^{dingir}Ninâ.[6] In the old Babylonian texts she is called "a child of NUN-^{ki},"[7] i. e., Eridu. Gudea calls her:

nin-en nin-me ^{dingir}KAL ^{dingir}KAL-LA
nin ^{dingir}En-lil-gim nam-tar-tar-ri.[8]

The epithet nin-en of Ninâ is found also in other inscriptions[9] —but always after Ninâ! To the nin-en must correspond, as we have seen, a lugal-en, and this is the epithet of ^{dingir}Nin-dar-a,[1]

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[1] "The king of the zu-ab, i. e., the apsû or abyss." Déc. 4 B^2. col. IV. 3.

[2] For references see E. B. H. Index, gods, p. 442, sub. D.

[3] See E. B. H. p. 298.

[4] Thus we ought to number and not as it was done in E. B. H. pp. 287 and 306 (List of months, the first two columns). The itu Ezen She-il-la, instead of being the first, ought to be the *last* (12th or 13th) month! See Thureau-Dangin's review of my E. B. H. in Z. A. XV. p. 409. The festival of Tammuz was celebrated in Phœnicia and Palestine, likewise originally in the 6th month, see Ezekiel viii. 1. (Masoretic Text). In later times, beginning with the first dynasty of Babylon about 2400 B. C., the month of sowing SHU-KUL-NA became the month Du-'-u-zu, i. e., Tammuz or the 4th month. E. B. H. p. 306 (list of months).

[5] Itu Ezen ^{dingir}Dumu-zi, E. B. H. p. 288, 306 (list).

[6] IV. R. 1, col. II. 38.

[7] ^{dingir}Ninâ dumu NUN-^{ki}, Gudea, Cyl. A. XX. 16. Comp. *ibid.* col. II. 15, NUN-^{ki} is the city of NUN or EN-KI!

[8] Mistress of the priests, mistress of the decrees (? ME or better divinations then = shib for me!) of the ^{dingir}KAL, mistress who like En-lil decrees the fates. Gudea, Cyl. A. IV. 8, 9. Comp. also Thureau-Dangin, Songe de Goudéa, C. R. 1901, p. 119, and the other epithet: en-me-li (= enshi), Cyl. A. II. 1, 16, III. 26; IV. 12 *et passim*.

[9] E. B. H. pp. 193, 224 note 4, 87 note.

[10] E. B. H. p. 193. Ur-Ba-u, col. V. 2 (K. B. III^1. p. 24).

who becomes thus the husband of ^{dingir}Ninâ. Of him we know in other respects nothing.

A *second* name of the husband of Ninâ was ^{dingir}Nin-dub, "the lord of the tablet (writing)," who together with Nin-Gir-su and Nidaba appeared unto Gudea in his dream, and who presented unto Gudea the "plan of the temple E-ninnû."[1] In another place[2] he is called "lugal-en" and has therefore exactly the same title as ^{dingir}Nin-dar-a, and is thus identical with the latter.

A *third* name of Nin-dar-a was ^{dingir}Lugal-Erim-^{ki}.[3] Ur-Ba-u calls himself the nitagh ki-ag, "the beloved servant" of this god.[4] My reason for identifying ^{dingir}Lugal-Erim-^{ki} with ^{dingir}Nin-dar-a = ^{dingir}Nin-dub = ^{dingir}Ud-mà-Ninâ-^{ki}-shurit-ta (see below) is this: Lagash or Shirpurla consisted of four suburbs, each suburb being called after the name of a god, or better, being dedicated to a god. These suburbs were:

1. Gir-su-^{ki}, with ^{dingir}Nin-Gir-su as its god.
2. Uru-azag-ga with the wife of Nin-Gir-su: ^{dingir}Ba-u as its patroness.
3. Ninâ-^{ki} with ^{dingir}Ninâ, and
4. Erim-^{ki} with ^{dingir}Lugal-Erim-^{ki}.

It seems probable that Ninâ-^{ki} (^{dingir}Ninâ) stands in the same relation to Erim-^{ki} (^{dingir}Lugal-Erim-^{ki}) as does Uru-azag-ga (^{dingir}Ba-u) to Gir-su-^{ki} (^{dingir}Nin-Gir-su). In this case, we would have here "two couples," each couple consisting of *husband* and *wife*. These couples are also "brothers and sisters"—for ^{dingir}Ninâ expressly calls ^{dingir}Nin-Gir-su *my brother*.[5] If this observation be true, then ^{dingir}Lugal-Erim-^{ki} would be

(1) the husband of Ninâ and

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[1] See Gudea, Cylinder A. col. VI. 5 and V. 2 (where he is not mentioned with name) and Thureau-Dangin, Songe de Goudéa, p. 121.

[2] I. R. 5, XXIII. = Winckler, *Altbabylonische Keilschrifttexte*, p. 4, No, 11a,

[3] E. B. H. p. 113. Jensen, K. B. III[1]. p. 20 (Ur-Ba-u col. II. l. 2).

[4] Jensen, *l. c.*

[5] Gudea, Cyl. A. V. 17 and 11. See below, p. 594, 5.

(2) the brother of Nin-Gir-su, i. e., he would belong to the descendants of ^{god}KI and thus be a son of ^{dingir}EN-KI.[1]

Other attributes of Ninâ are: en-me-li-azag[2] or en-me-li dingir-ri-ne;[3] nin-in-dub-ba.[4] ^{dingir}Ninâ calls ^{dingir}Nin-Gir-su "my brother,"[5] and ^{dingir}Nidaba "my sister."[6] ^{dingir}Ninâ is also called the NIN of ^{dingir}Ud-mà-Ninâ-^{ki}-shurit-ta.[7] It may not be impossible that this ^{dingir}Ud-mà-Ninâ-^{ki}-shurit-ta be a *fourth* name of her husband[8] ^{dingir}Nin-dar-a.

The firstborn of Ninâ was ^{dingir}Nin-Mar-^{ki}.[9]

To KI's line belongs, no doubt also ^{dingir}Gal-dim-zu-ab.[10]

From Old Babylonian inscriptions we cannot as yet make out the father or the mother of EN-KI himself, but a later text tells us that "^{dingir}GUR was the mother of god Ea."[11] Who or what is this ^{dingir}GUR?

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[1] It should be observed here, that the husband of a wife is at the same time *always* her brother! Comp. ^{dingir}EN-LIL and ^{dingir}Ba-u. See also Winckler, M. V. A. G. 1901, 4, p. 14 ff.

[2] Gudea, Cyl. A. II. 1 III. 16. For en-me-li to be pronounced enshi, see Br. 2918. Br. Mus. 82-8-16, 1 (= A. W. p. 54 f. = Hom. S. L. p. 97) l. 21. Thureau-Dangin translates it by "divineresse," Songe de Goudéa, p. 116.

[3] Gudea, Cyl. A. II. 16, IV. 12.

[4] "Mistress of tablet writing," Gudea, Statue B. VIII. 53. E. B. H. 193.

[5] Shesh-mu ^{dingir}Nin-Gir-su, Gudea, Cyl. A. V. 17, comp. with l. 11. See also Gudea, Statue D. IV. 2-3 (K. B. III^{1}. p. 52), where Ninâ and Nin-Gir-su are coupled together.

[6] Gudea, Cyl. A. V. 25: nin (notice the sign for nin)-mu ^{dingir}Nidaba.

[7] Gudea, Cyl. A. II. 1, 17, III. 27, IV. 5 (E Kisal ^{dingir}Ud-mà-Ninâ-^{ki}-shurit-ta). Nin here = sister? (notice the sign!). E. B. H. p. 193 (where instead of tag = shurit must be read on account of the prolongation syllable. For TAG = shurit see S^{c} 292).

[8] In this case NIN = "Mrs." or "wife of"; see above, p. 583. The temple of Ninâ was called E-Ud-mà-Ninâ-^{ki}-shurit and was situated in Ninâ-^{ki}, a suburb of Shirpurla-Lagash, E. B. H. p. 193.

[9] Ur-Ba-u V. 10 (K. B. III^{1}. p. 24): ^{dingir}Nin-Mar-^{ki} sal-shag-ga dumu-sag ^{dingir}Ninâ, i. e., Nin-Mar-^{ki} (the mistress of Mar, a city), the gracious lady, the firstborn of Ninâ. See also Gudea, Statue B. IX. 1 (K. B. III^{1}. p 46).

[10] E. B. H. p. 106.

[11] IV. R. 1, col. II. 36. The god Ea is "EN-KI." The sign GUR is = NI-GIN + inserted GHAL, the same as in Ur-Gur, king of Ur. For the reading EN-GUR instead of GUR see above, p. 583, note 4

Hommel[1] identified ^{dingir}GUR with ^{dingir}Ba-u. He was able to adduce seven "reasons" for his supposition. The very fact that he brought in just *seven* "reasons" was at once a bad omen. He introduces his seven reasons thus (p. 220):

"Da Bel, wie der Eigenname [2]E-KUR-dumu[2]-nunna (d. i., Igur Sohn Nunna's) beweist, als Sohn des Himmelsoceans von den Babyloniern aufgefasst wurde (vgl. auch noch Ursp., S. 37, Z. 6 v. u. Bel mâr rishtû shamí), so ist es nach der stereotypen Folge Anu, Bel, Ea, *mehr als wahrscheinlich, dass sie auch den Ea als Sohn Bel's betrachteten*[3] und dass in der Reihe Anum (Nun, anna), Bel (Gun-lilla), Ea (Gun-kia oder Dugga), Merodach, die älteste babylonische Göttergenealogie vorliegt."

His argument about the sonship of Ea, then, is this: "On account of the stereotyped sequence Anu, Bel, Ea, it is *more than probable* that Ea was the son of Bel!" Upon this pillar of truth, this unquestionable fact of proof, his whole argument is built up. But let us go on. He says:

"Anum hat keine Gemahlin....das Fem. Anatu der lexicalischen Listen (ist) erst eine spätere Abstraction, welche in den alten bilinguen Texten wie in den Inschriften von Tello noch nirgends vorkommt."

This, I suppose, he probably will no longer maintain now, because the "An-nat" of Annu-bânini will be known to him. Annu-bânini lived even before Sargon I., i. e., before 3800 B. C.,—hence "An-nat" or the wife of Anu was known as early as that. He then speaks of the wives of Enlil and enumerates the Nin-lilla and the Nin-ghar-sagga and says:

"Ein anderer (viz., name of the wives of Enlil) war [4]^{dingir}GUR,[4] eine ausgesprochene Himmelsoceansgöttin, welche in den bilinguen Texten als "Mutter des Gottes Ea" (*also demnach als Gemahlin des Vaters des Ea, eben des Bel*)[5] bezeichnet wird (4 R. i. 36 b)."

Because Ea was *declared on account of the stereotyped sequence*: Anu Bel Ea, to be *the son of Bel*, and because ^{dingir}GUR is the

[1] "Die Identität der ältesten babylonischen und ägyptischen Göttergenealogie und der babylonische Ursprung der ägyptischen Kultur, in *Transactions of the International Congress of Orientalists.*" Von Prof. Dr. Fritz Hommel. London, 1893.

[2] Given in cuneiform signs.

[3] Italics are mine.

[4] Given in cuneiform signs.

[5] Italics are mine.

mother of Ea, hence he follows ^{dingir}GUR *must* be also the wife of Bel! This argument, then, is again built upon the *sequence* merely. He goes on:

"Als Göttin aber *scheint*[1] ^{dingir}GUR[1] nicht die Aussprache GUR gehabt zu haben, sondern Ba'u....das geht aus folgenden....Gründen hervor:

"1. Die Göttin Ba-u heisst in den Gudea-Inschriften stets 'Tochter des Himmels,' ist also eine Schwester, resp. (was in der babylonischen Mythologie oft dasselbe ist) Gemahlin des Gottes Bel, demnach identisch mit der Göttin Nin-lilla oder der [1] ^{dingir}GUR,[1] welche letztere ja Mutter des Gottes Ea heisst."

Ba-u is the wife of Bel, hence the same as Nin-lil or ^{dingir}GUR, who is the mother Ea. Hommel wishes to prove that Ba-u = ^{dingir}GUR, but takes it for granted that ^{dingir}GUR is = Nin-lil, without any arguments of his,—a fair exhibition of Hommel's argumentation! He continues:

"2. In einer Zauberformel (4 R. 29, No. 4) ist die [1] ^{dingir}GUR [1] die Helferin der Kranken, besonders solcher an Augenweh leidenden....in einem ähnlichen ....Text, K 2378 + 224, wird sie unmittelbar nach der Göttin Nin-agha-kuddu (der Schwester Ea's) erwähnt als 'Herrin der reinen Gewässer,' nin a-gub-ba íl-la. Auch die Ba-u wird (in H., K. T. 11. xxvi) gegen Kopf-, Herz-, und Augenweh zugleich mit Nin-agha-kuddu und Gula angerufen."

^{dingir}GUR and Ba-u are invoked in case of sickness; especially when the eyes are diseased, twice they are coupled together with Nin-agha-kuddu,—hence ^{dingir}GUR = Ba-u,—a strong argument, indeed! For the same reason Hommel might have argued that Gula, a later name for Ba-u, is = Nin-agha-kuddu = ^{dingir}GUR,—for he might have substituted for Ba-u the Gu-la! By such argumentations we can prove *nothing, absolutely nothing, and everything!*

"3. Die [1] ^{dingir}GUR [1] trägt den Beinamen 'mit reinen (azagga) Händen'; die speciell der Ba-u heilige Stadt ist URU[1]-azagga, d. i., 'reine Stadt' (wol gleich Nipur)."

Because the word "azagga, pure," occurs in connection with "hands" in case of ^{dingir}GUR and in connection with URU or "city" in case of Ba-u,—hence ^{dingir}GUR = Ba-u! Further comment is unnecessary. Uru-azagga is not Nippur, but a suburb of Shirpurla.

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[1] Given in cuneiform signs.

"4. Das Ideogramm GUR[1] wird von den babylonischen Gelehrten ausdrücklich als 'Himmel' (ziku = shamû) erklärt (2 R. 50, 27), und die Ba-u heisst stets (siehe schon oben unter No. 1) 'Tochter des Himmels.'"

The sign GUR (notice, not [dingir]GUR) is = heaven, Ba-u is = daughter of heaven, hence GUR = Ba-u or heaven = daughter of heaven! And I may add [dingir]GUR = [god] of heaven = heaven = daughter of heaven, one follows from the other! The heaven becomes his own daughter! Splendid argumentation!

"5. Wie es einen Gott [1 dingir]EN-GUR[1] (= Ea, dann als Sohn der [1 dingir] GUR,[1] urspr. aber wol = Bel) gibt (Jens. Kosmol., S. 245), so gab es auch einen Gott [1 dingir]EN[1]-Ba-u [here Hommel refers to a note: vgl. auch 3 R. 67, 57....[1 dingir]GUR[1]-ra, NIN-[1 dingir]GUR[1]-ra, woraus zugleich hervorgeht, dass man später allerdings [1 dingir]GUR[1] Gurra las, was aber natürlich für die alte Zeit nichts beweist] Urspr., S. 19, Anm. 1). Wie es einen altbabylonischen Königsnamen Ur-[1 dingir]GUR[1] gab,....so gab es auch.... einen Ur-[dingir1] Ba-u."

The nonsense that follows is too great to be reproduced here, and has, I suppose, been given up by Hommel himself. His argument is this: GUR = Ba-u (which he wants to prove, mark ye!), "Gleiches zu Gleichem zugesetzt giebt Gleiches, und Gleiches von Gleichem abgezogen giebt Gleiches." If we add to GUR and Ba-u a [dingir]EN we get the same, and if we abstract from [dingir]EN-GUR and [dingir]EN-Ba-u, a [dingir]EN we get again the same—but this presupposes that GUR is already = Ba-u, which Hommel wishes to prove by this No. 5!

"6. [1 dingir]GUR[1] ist bei den Aegyptern die Morgendämmerung (siehe unten) wie bei den Babyloniern die Bau-u (3 R. 55, 49b)."

Here Hommel takes something as *proven*, which he has not yet proved!

"7. Endlich wird die Göttin [1 dinger]GUR[1]....in späterer Zeit in ganz gleicher Weise zur Gemahlin Nirgal's (4 R. 33½, col. 3, 30; vgl. 2, 46, die Gula als Gemahlin Nindar's) wie andererseits . . . die Ba-u, zur Gemahlin des Ningirsu (= Nirgal) wird (Statue G. 2. 6), während doch sonst die Göttin [1 dingir]Ninâ[1] (Ghanna) die Schwester (Gudea, Cyl. A. 5, 17) und Gemahlin des Ningirsu-Nirgal ist."

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[1] Given in cuneiform signs.

Hommel presupposes or takes for granted without any further argument of his that Ningirsu is = Nirgal. He first must prove this, then we shall want to answer him. Jensen, e. g., takes Ningirsu to be = Ninib, see K. B. III[1]. p. 23, note *†. We do not know as yet who this Ningirsu is! But see below!

The best, however, follows:

"Aus all diesen Anführungen," says Hommel, "*geht hervor*,"[1] dass [2]dingir GUR[2] and dingir[2] Ba-u *reine Synonyma*[1] sind, *ganz dieselbe Göttin von Haus aus bezeichnen*,[1] und dass *höchst wahrscheinlich*[1] auch die gewöhnliche Aussprache von [2]dingir GUR[2] Ba'u war, während die andere Aussprache gur offenbar nur dem unpersonificirten mythologischen Begriff GUR[1] (ohne Gottheitsdeterminativ) eignete. Ich habe dies deshalb so ausführlich und eingehend hier BEWIESEN,[1] weil in einem viel citirten Buche die betreffende Identification eine 'auch jeglicher Begründung entbehrende' genannt worden ist (Jensen, *Kosmologie*, S. 245)."

And I have taken this trouble to present to the public the splendid PROOFS of Professor Hommel, to show what nonsense they are. I do not possess Jensen's *Kosmologie*, nor is it accessible to me, hence do not know what arguments Jensen adduces to disprove Hommel. But arguments are not necessary at all to disprove the *above*-given "reasons"; every man with a little common sense will see instantly that they are nonsensical. To quote Hommel[3] again:

"Wer so einen Unsinn denken, schreiben und schliesslich drucken lassen kann, der hat überhaupt den Anspruch ernst genommen zu werden verwirkt."

All seven "reasons" of Hommel are built upon the sequence of Anu, Bêl, Ea, which suffices to *prove* for him that *Ea was the son of Bêl*, and because Ea was also the son of dingir GUR he follows, that dingir GUR must have been the wife of Bêl, and thus the same as dingir Ba-u!

The only passage in the old Babylonian inscriptions, where the sequence Anu, Bêl, Ea may be found is that of Gudea, Statue B. Col. VIII. 45 ff.: An-e dingir En-lil-li, dingir Nin-char-sag dingir EN-KI. And here Ea or dingir EN-KI is divided from Bêl or dingir En-lil by the wife of the latter! In all the other oldest inscriptions the

[1] Italics and capitals are mine. [2] Given in cuneiform signs.

[3] Hommel, *Die Südarabischen Alterthümer des Wiener Hofmuseums*, p. 12 = *Aufsätze und Abhandlungen*, II. p. 140.

sequence of the gods seems to be without any special order, as one can easily convince himself, by examining the inscriptions with regard to this point. Furthermore the celebrated trilingual list of gods,[1] written in EME-SAL, Sumerian, and Semitic Babylonian, does NOT give the names of the gods in the sequence An, Bêl, Ea—which it would have undoubtedly done, if Ea had been the son of Bel, as Hommel supposes—but in the order Anu,[2] Ea, Bel. The same arrangement, viz.: Anu, Ea, Bel is found again in IV. R. 1, 61c ff. Hence, the sequence Anu, Bel, Ea would not prove anything at all. And if it does not, then is Hommel's statement, to say the least, nonsense, that it is "nach der stereotypen Folge Anu, Bel, Ea, *mehr als wahrscheinlich*, dass sie (the Babylonians) auch den Ea als Sohn Bel's betrachteten und dass in der Reihe Anum, Bel, Ea, Merodach, die älteste babylonische Göttergenealogie vorliegt." And if the sequence Anu, Bel, Ea does not prove anything, then it also follows that dingir GUR is not proven to be the wife of Bel or = Ba-u! The other seven arguments or "reasons" (Gründe) of Hommel are so foolish as to require no further refutation.

But who then was dingir GUR? In order to answer this question it is necessary to inquire into the meaning of god AN and god KI!

The sign AN is translated in Semitic Babylonian generally by shamû, i. e., "heaven," and the sign KI generally by irtsitu, i. e., "earth." Both signs occur very often together in the attributes of En-lil (lugal-an-ki[3]) and Nin-char-sag (nin-an-ki[3]), where they no doubt stand for "heaven and earth." That the original meaning of AN was not so much "heaven" and that of KI not so much "earth" is evident from the following considerations:

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[1] II. R. 59 (see Hommel, S. L. p. 46).

[2] Anu is called in the EME-SAL column = dim-me-ir; in the Sumerian: AN; and in the Semitic: i[-lum], i. e., the god *κατ' ἐξοχήν*. From this it would follow that the writing AN-E might also be read dingir-e, and that of AN-tum = il-tum, and lastly that of NI-NI-tum = ì-lì-tum, but in every case it would signify either the "god" or the "goddess" *κατ' ἐξοχήν*, i. e., Anu and his wife Annat.

[3] See above, p. 586, 4. 5. 6.

(1) "Heaven" in Sumerian means GISH and in EME-SAL: mu.[1]

(2) In the expression AN-ta = elish and KI-ta = shaplish, the AN stands simply for "that which is above" and the KI for "that which is below." Thus it happened that Jensen explained the name dingir EN-KI by "Herr, dessen was unten ist" = Ea.[2] If this explanation be correct, it would follow from the analogy of the case that the name AN or EN-AN[3] would have to be translated by "he who is above" or by "lord of that which is above."

This idea of "being above" and "being below" is no doubt the original one, and because "that which is above" was considered to be the heaven thus it came in course of time that AN stood for heaven, and KI "being that which is below" came to mean "earth."

3. En-lil, we have seen, was in later inscriptions also called E-KUR-dumu-nunna, i. e., E-KUR,[4] the son of *Nunna*. If this be true, then AN, the father of Bêl (see above: Bêl mâr rêshtû shamê) must also *have been*, or been called, a NUN!

4. But dingir EN-KI or Mr. KI was *also* called NUN as is apparent from the name of his wife dingir Dam-gal-nun-na, "the great wife of NUN." What this NUN means we know; it is the zu-ab or apsû, the ocean.

Thus we see instantly that AN was "the upper ocean" and KI the "lower ocean," or "*the heavenly ocean*" and "*the terrestrial ocean*," or as the Bible calls it, "the waters above the firmament" and "the waters below the firmament." This specific meaning of god AN and god KI has been recognised already by other scholars, even by Hommel, although I do not know what arguments he brought in.

Having thus established the *original* meaning of the words AN and KI respectively, we may turn to the relationship of AN and

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[1] Trilingual list of gods, II. R. 59, col. II. l. 47.

[2] K. B. III[1]. p. 21, note †.

[3] Comp. the proper name EN-AN-NA-tum and see above, p. 591, 6.

[4] E-KUR is originally the name of the *temple* of En-lil at Nippur.

KI, i. e., inquire whether god KI was the son of En-lil and thus the grandson of ^{god}AN, or whether he was something else.

In Assyrian we have a word achu which means "brother" and also "side." If this very same word is written achû (contracted out of achâiu) it means "enemy." Both words no doubt go back to the same root. But how then could the word achu possibly get the meaning "enemy" and be written achû? My explanation is this:

Achû, or achâiu, literally means: "he who or that which belongs to the brother," comp. Nippurû out of Nippurâiu, "he who belongs to Nippur," i. e., "a Nippurian." But "a brother" is in *every case* "the other," i. e., the "one who is not the *ego*," "who is in opposition to the ego," "who is opposed to the ego," and the one that is opposed to my ego is "my brother" and "my enemy!" If a person or a god is called "AN," then he who is his achu *had* to be called "KI" and as such he is "*in opposition to*" (an achû!) to the AN. If AN means the "*heavenly* ocean" and KI the "terrestrial ocean," we have here an achu in so far as they are both an ocean, hence also of the same *stock* or *parents*, but also an achû in so far as the KI is opposed to the AN, "the *terrestrial* ocean" to "the *heavenly* ocean." Comp. here also AN-SAR and KI-SAR; as SAR they are achu, as AN and KI they are achû![1]

And now, if ^{dingir}GUR is called the mother of god Ea or Enki, it follows, because EN-KI is the achu and achû of god AN, that ^{dingir}GUR *must* be the mother of ^{god}AN too. AN and KI being the "heavenly and the terrestrial ocean," ^{dingir}GUR can only be the "primeval ocean." And it is more than mere accident that we should have handed down to us the following three writings of this

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[1] See also Winckler who has partly anticipated me here,—although his investigations are in quite another field,—who says in M. V. A. G. 1901, 4, part 1, p. 15, note 1, which has just come to hand: "Mythologisch—und damit im Zusammenhang der ganzen Weltauffassung—erscheint das Brudermotiv—wie alle—also in den zwei Gegensätzen, denn jedes Ding schlägt schliesslich in sein Gegentheil um, wie es der *Kreislauf* der Natur vorschreibt und bedingt. Wir haben die unzertrennlichen und doch getrennten Brüder: Dioskuren, Mond und Sonne = Nacht und Tag = Licht und Finsterniss = Winter und Sommer, die beiden Sonnen—und Naturhälften. Diese sind die *feindlichen* Brüder, deren einer den anderen tötet: Eteokles und Polyneikes, Baldr-Hödur (dessen Blindheit *Mond*motiv ist.)

deity: dingir GUR, dingir EN-GUR, dingir NIN-GUR. The last two stand for Mr. and Mrs. GUR, i. e., for apsû and tiâmat, for תהום and מים, or for חשך and רוח אלהים respectively. dingir GUR on the other hand signifies only god GUR, without laying special emphasis upon the male or female part, or *husband* and *wife*. dingir GUR thus becomes "the *primeval ocean, κατ' ἐξοχήν,*" and is as such *older* than NIN-GUR or EN-GUR. This also proves that we had originally only a god KI,[1]—and because the heavenly is only a reflex of the earthly, this god KI became a wife: a NIN-KI, "Mrs. KI"; and in order to distinguish the wife from the husband, or better, in order to avoid *misunderstanding*, the husband was called EN-KI, Mr. KI; for dingir KI alone, if used also of Mr. KI, would leave it doubtful whether god KI as a *whole*—male and female—were meant, or whether it stood for EN-KI only.

Furthermore, if dingir GUR (notice not dingir NIN-GUR, as we might expect) is called the *mother* of EN-KI, we may see in this a striking parallel to the Babylonian creation story as well as to the Biblical,—according to both the heavenly and terrestrial ocean take their origin from the tiâmat or tehom, i. e., the *descent was reckoned through the mother*.[2]

Tehom and tiâmat even in later times are used for "*ocean*" without any special reference to a mythological being as consisting of two genders: the male and female gender; so GUR may have been primarily the *ocean* and only in later times acquired this mythological conception of being male and female, thus able to generate and perpetuate itself. However this may have been, all suggestions that might be made here are at the very best only guesses. May it suffice therefore to have shown that dingir GUR was the primeval ocean who *brought forth* by process of *generation* —notice *generation*—two sons: AN and KI, who later on were together with GUR thought to be male and female, and thus able to perpetuate their own lines respectively. Having made this probable, we can now explain the succession: Anu, Bêl, Ea as well as Anu, Ea, Bêl. In this latter sequence the two brothers are men-

[1] See above pp. 580, 9; 582 ff.

[2] See above p. 576.

tioned first, then follows Bêl as the son of Anu. In the former sequence we have the father Anu together with his son Bêl, and Ea is the 'am, the *fathersbrother*, who plays such an important rôle in old Arabic inscriptions that even the word itself became a god, —the god 'Am.[1] Anu, Bêl, Ea, is thus proven to be what the Arabs call a racht, i. e., a community consisting of a head or "abu" = Anu, of an 'am = Ea, and of a nephew = Bel,[2] who form the first triad in the Babylonian pantheon as well as in the Assyrian, which triad, as we have seen, goes back to the Sumerian conception of the theogony and cosmogony.

As AN, originally the "heavenly ocean," became in later times the shamû or "heaven," thus KI, originally the "terrestrial ocean" became later on the irtsitu or "earth." We would expect that AN and KI became in consequence of this also the "god of heaven" and "the god of earth" respectively. But this is not the case. The "god of heaven and earth" was Bêl, for he is repeatedly called the "lugal-an-ki, "the king of heaven and earth." "Heaven and earth" were thus considered to be closely connected, yes, to be *one*, and what this *one* thing was called, we shall see, when we come to speak of dingir En-lil.

And if "heaven and earth" were considered to be one, it is, of course, natural, that we should not find a god in this Sumerian theogony who is called LUGAL-KI, shar irtsiti "the king of the earth." Hence, there does not seem to have existed at the time of the Sumerians a so-called "ba'al of the soil," who plays such an important rôle among the Semitic peoples.

The god KI had sons and daughters, all of whom we have met already above. It only remains here to explain their names. The sign by which Ninâ is expressed is composed of ESH or AB = "abode," with inserted CHA or "fish." Signs, when inserted into another sign, may be either an indicator of the pronunciation or an indicator of the sense. The latter I take to be the case here.

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[1] See Hommel, *Die südarabischen Alterthümer des Wiener Hofmuseums* München, 1899, p. 28 ff.

[2] See also Proksch, *Die Blutrache bei den alten Arabern*, p. 23, and Winckler, *M. V. A. G.*, 1901, 4, p. 16.

The sign "fish" may either stand for "fish" itself, or for "plenty." Ninâ then would be either a fishgoddess, or a goddess of plenty. The goddess Nidaba[1] "was the goddess of grain," as even the Ideogranun indicates it.[2] dingir Dumu-zi because = ilu Du-'-u-zu, and because to him was dedicated originally the sixth and in later times the fourth month called SHU-KUL-NA or "month of sowing" must have been "the god of verdure."[3]

According to the analogy we should expect for Ninâ's husband also some such signification as "verdure," or "fishes," or "plenty," or "grain;" this however cannot be made out as yet. It may not be impossible that the name dingir Nin-dub, because dub means "clay," then "clay tablet," may make that god to have been originally "the god of the clayground." However this may have been, the significations of the names of Ninâ, Dumu-zi, Nidaba, suffice to show us that we have to see in them the gods of either "what the earth produces" or "what the sea produces." If this be true then it follows that the dingir EN-KI, the "terrestrial ocean," was thought to contain the *earth also*, i. e., he was "the waters which contained the dry ground," or else he could not have produced sons or daughters who are the gods of "the *produce of the earth*"! As already said above, the Sumerians do not seem to have had "a god of the dry land or soil "κατ' ἐξοχήν."

What may possibly be the reason for this phenomenon? We know from the Gilgamesh epic—and our present investigation confirms it, as we shall see—that Eridu or NUN-ki, the city of Ea or EN-KI was one of the oldest cities of Babylonia, from which practically the whole of the specific Babylonian religion took its origin. Eridu, when the Gilgamesh epic was written, was a seaport town on the Persian Gulf, while to-day it is one hundred and thirty miles

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[1] For references see E. B. H. Index, gods, p. 444, sub. N.

[2] See Br. 7453, and comp. Trilingual list of gods, 2 R. 59, I. 24, where she is called the "wife of dingir Lugal-ki-sá(di)-a."

[3] In the sixth month the festival of "the dying of the verdure," while in the fourth month that of "the new life of the verdure" was celebrated. The former was the festival of the wailing for Tammuz, the latter that of his resurrection. See also Dr. Carus, *The Monist*, July, 1901, pp. 528 ff.

from the coast line. Here the Sumerians of old saw how new earth or dry land was added year by year to the already existing dry ground. Hence it was quite natural for them to think that "the earth was contained in the terrestrial ocean." But water is also necessary for vegetation! Hence also, vegetation, verdure of the dry ground, were made to be children of dingir EN-KI. In the ocean are also fishes, etc., and thus Ninâ the fishgoddess became of necessity his child. Thus we would expect "the ba'al of the soil" to be a son of EN-KI. It may very well be possible that future investigations will shed light upon this question. At the present it will be best not to put too great an emphasis upon this omission, for any of the gods not yet identified may become in future times "a god of the soil."[1]

The firstborn of EN-LIL or Bêl is the god ZU, i. e., dingir EN-ZU or also called dingir Uru-ki. This latter is translated into the Semitic-Babylonian by Nannar,[2] i. e., "the luminary." The "na-an-na-ri shame-e ù irtsitim," or "the luminary of heaven and earth,"[3] was god Sin. And "Sin" translates the Sumerian EN-ZU. In the Monolith Inscription of Shalmaneser II.[4] we have a god called "ilu Na-nir shame-e irtsi-tim," i. e., "the god the luminary[5] of heaven and earth." Hence there can be no doubt that EN-ZU is = Uru-ki = Sin = Nannar = Moon. What the name ZU means we cannot tell. It is explained in the syllabaries by "to know," "to be wise," "to learn," "to understand," etc., etc.

It may be probable that Gudea[6] of old was obliged to confess of Sin: dingir En-zu mu-ni galu-nu-gab-ne: "Sin—his name no man has ever disclosed, understood, explained," because he—Sin—treading his quiet path for all those ages past acquired in course of time a wisdom and knowledge so great that they cannot be

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[1] Does perhaps the dingir Dun-gur-(an) belong here, who is called the dingir En-temen-[an] (E. B. H. p. 118, note 1)? The temen-an, the "foundation of heaven," would be the "*earth*." But a ba'al of the soil is quite different from a ba'al of the earth. See however below!

[2] IV. R. 9 $\frac{3}{4}$–$\frac{11}{15}$a. [3] V. R. 64, 18. [4] III. R. 7, col. I. 2.

[5] "Die göttliche Leuchte," or "der göttliche Leuchter."

[6] Gudea, Statue B. VIII. 49 (K. B. III^1. p. 46).

disclosed, for he saw many things which nobody else has seen and heard many things which no man ever could have heard—in short "Sin was the god who not only could not be disclosed, or understood, but who also did not disclose, open, betray anything himself."

This god "who passes our understanding" had two children, UD and dingir Innanna. The god UD "the bright, or shining one," is called in the oldest inscriptions, "the king filled with splendor,"[1] and is identified in the later inscriptions with the god Shamash or "the sun." His sister or wife—for that is the same in the oldest inscriptions[2]—is the "goddess of Innanna." What the Innanna was we cannot tell as yet. She was later on identified with the "evening star" as well as with "the morning star," the former being the precursor of the moon, the latter that of the sun. As "morning star," which leads the king out to battle, she was considered in later times to be a male, a god, but retained her feminine name and was called either Ishtar or A-nu-ni-tum bêlit tachâzi.[3]

This latter title she had already in the oldest inscription, where she is called "nin mè,"[4] i. e., mistress of battle—hence *feminine!* It may not be impossible that even in the oldest time dingir Innanna was assigned to both functions, viz., to that of "the evening star," thus becoming "the goddess of love," and to that of "the morning star," as such being called the mistress of battle. The Innanna then would express the function common to both: the morning and the evening star. This function in every case must be a double one: the morning star announces the end of the night but also the beginning of the day; the evening star in like manner shows that

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[1] See, e. g., Gudea, Statue B. VIII. 63 (K. B. III[1]. p. 46): lugal-zal-sig-ga. E. B. H. p. 76 *et passim.*

[2] See above Enlil and Ba-u—both "the firstborn of An," hence brother and sister, but also husband and wife.

[3] A good example of this may be found in Nabû-nâ'id, Thoncylinder aus Sippar, A.-W. *Keilschrifttexte*, p. 42, col. III. l. 23 ff., where A-nu-ni-tum is treated both as a masculine and a feminine deity.

[4] Gudea, Stetue B. VIII. 61 (K. B. III[1]. p. 46).

the day is at its close and that the night is beginning.[1] The god Nin-Gir-su, the city-god of Girsu, whose real name we do not know as yet, was, as we have seen, a son of dingir En-lil, hence, a brother of god ZU, i. e., Sin or the moon, hence also, the ʿam, the "father's brother" of UD.

Who is this Nin-Gir-su?

Hommel[2] identified him with Nergal. Jensen,[3] with Ninib, the god of war. In another place[4] he reaches the same conclusion by the following consideration: The temple which Ur-Ba-u and Gudea built for Nin-Gir-su was called E-ninnû, i. e., the temple of the number fifty, and ninnû is again = Ninib.[5] This E-ninnû was also called E dingir Im-gig-ghu-bar-bar. From this Jensen concludes (*l. c.*): "dingir Im- etc. ist eine Erweiterung des Namens. Die Gruppe ist zu deuten: (des Gottes) welcher den finstern (gig) Himmel (im) erhellen (bar-bar) möge (ghu), und spielt auf Ninib als die Frühsonne an." This explanation was also accepted by me in my E. B. H[6].

Thureau-Dangin,[7] on the other hand, separated the latter name into dingir Im-gig-ghu and bar-bar, i. e., "the divine bird Im-gig" and "bright," the bird he identified with the eagle, the well-known emblem of Shir-pur-la—Girsu, referring at the same time to M. Heuzey, *Origines orientales*, p. 41, where an imprint of a seal-cylinder is published which is said to contain a representation of Nin-Girsu as described by Gudea in his celebrated dream. On account of the importance of the passage in Gudea's dream it might seem well to examine it more closely.

Gudea has a dream[8] in which appears to him a "man." The description of this "man" is given in all its details. Gudea does not know this "man" who had commanded him to build the temple

[1] See the sign SUCH (= Innanna) V. R. 44, l. 14. 15, and H. W. B. p. 541 sub. פרכה IV. 1.

[2] Identität, etc., p. 222. See above, p. 597 sub 7.

[3] K. B. III[1]. p. 19, note **, where he quotes II. R, 57, 74.

[4] K. B. III[1]. p. 23, note *†. [5] V. R. 37, 18.

[6] See p. 182, note 1; p. 185, note 10. [7] Z. A. XV. p. 52.

[8] Zimmern, Z. A. III. 232–235. E. B. H. p. 189. Thureau-Dangin, Z. A. XV. p. 50. *Songe de Goudéa*, C. R., 1901, p. 112.

E-ninnû. He therefore addresses goddess Ninâ for an explanation of the dream, and she informs him that that man was her brother "Nin-Girsu."

The description which Gudea gives of "the man," reads[1]:

14. shag ma-mu-da-ka (ga)lu-I-a-an an-gim RI-BA-ni
15. ki-gim RI-BA-ni
16. A-NE sag-ga-ni-ku dingir-ra-an
17. id-ni-ku dingir Im-gig-ghu dam
18. sig-ba-ni-a-ku A-MA-SHUB-kam
19. zi-da gub-na UG ni-nad-nad
20. e-a-ni ru-da ma-an-dug
21. shag-ga-ni nu-mu-zu[2]

Which might be translated:[3]

14. In the midst of my dream (behold): A man—like the heavens his RI-BA
15. like the earth his RI-BA—
16. A-NE above him—surely a god!
17. At his sides there was dingir Im-gig-ghu,
18. At whose feet there was an A-MA-SHUB
19. At the right and his left an UG was couched
20. His house to build he commanded me
21. Him (lit. his heart) I did not know.

The goddess Ninâ, when explaining to Nin-Gir-su the meaning of this dream, uses the following words[4]:

13. (ga)lu an-gim RI-BA ki-gim RI-BA-ku
14. sag-ga-ku dingir id-ni-ku
15. dingir Im-gig-ghu-ku sig-ba-a-ni-ku A-MA-SHUB-ku

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[1] See especially Thureau-Dangin, Z. A. XV. 51.

[2] Gudea, Cyl. A. IV. 14–21.

[3] Thureau-Dangin, *l. c.*, and *Songe de Goudéa*, p. 119, translates:

"Au milieu de (mon) songe, un homme grand comme (so no doubt better than the 'dont la taille égalait' in Z. A.) le ciel.
Grand comme (Z. A.: dont la taille égalait) la terre
Sur la tête de qui était une *tiare* (Z. A. . . . for tiare) divine
À côté de qui était l'oiseau divin IM-GIG
Aux pieds de qui était un ouragan
À la droite et à la gauche de qui un lion était couché
M'a ordonné de construire sa maison:
Je ne l'ai pas reconnu."

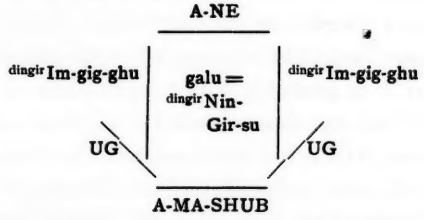
[4] Cyl. A. V. 13–18.

16. zi-da gub-na UG ni-nad-[1]nad-[1]a
17. shesh-mu [dingir]Nin-Gir-su ga-nam me-a-an
18. esh E-ninnû na-ru-ba za-ra ma-ra-an-dug.

Which when translated would read:[2]

13. The man: like the heavens in RI-BA like the earth in RI-BA
14. With that head—the god—at his sides
15. with a [dingir]Im-gig-ghu, at his feet with an A-MA-SHUB—
16. at the right and his left an UG being couched—
17. my brother [dingir]Nin-Gir-su surely is he,
18. the house E-ninnû to build he has commanded thee.

If we would draw a picture of the "man" Nin-Gir-su, we would have to do it as follows:



Intentionally some words were left untranslated above, because on the right interpretation of them depends everything.

A-MA-SHUB is, as Thureau-Dangin[3] has shown, the Semitic-Babylonian a-bu-bu, "stormflood."

[dingir]Im-gig-ghu, if translated word for word, would mean: [god] cloud, dark or black, bird or flying.

The two words suffice to show us that "the man" or Nin-Gir-su when appearing to Gudea was upon a "stormflood" and surrounded by "flying dark clouds." If bar-bar be added to E-[dingir]Im-

[1] The inscription gives SÀ-SÀ, which, no doubt, is a mistake for NAD-NAD, as is apparent from above, col. IV. 19.

[2] Thureau-Dangin, *Songe*, p. 120, translates:
13. l'homme grand comme le ciel, grand comme la terre
14. sur la tête de qui était (une *tiare*) divine, à côté de qui
15. était l'oiseau divin IM-GIG, aux pieds de qui était un ouragan
16. à droite et à gauche de qui un lion était couché
17. c'est mon frère, NIN-GIR-SU:
18. il t'ordonnait de construire sa demeure, l'E-ninnû.

[3] Z. A. XV. 51, note 5.

gig-ghu, we get the name of the temple E-ninnû dedicated to Nin-Gir-su. And because the E-ninnû is called the temple of DINGIR Im-gig-ghu-bar-bar, it follows that the latter name was also a surname of Nin-Gir-su. From this it also follows that "the flying dark clouds" are or may become sometimes "very bright"!

The UG, which are at the left and the right side of "the man's" feet will and must signify a similar thing. Now, I do not think that Thureau-Dangin is right in translating UG by "lions," although UG may have that meaning. Thureau-Dangin[1] himself says: "Il est probable que UG-GAL est identique à UD-GAL." UD has also the reading UG! And UD or better UG-GAL is translated by ûmu and means "storm" or "great wind."[2] UG alone would mean "wind" or "storm" too.[3] The A-NE at the head of this "man" might be taken either as the plural of A, i. e., "rain," "waters," or probably better as A + BIL, i. e., "water and fire." What this fire was we shall see directly.

The remaining RI-BA has been translated by Thureau-Dangin in his "*Songe de Goudéa*" quite correctly. It no doubt means that the man was as large or great as the heavens[4] and earth, extended over heaven and earth; his course[5] was so wide and so large that it went all over the heavens and the earth.

Thus the description might be interpreted as follows: There appeared a "man" to me who was as regards his size as large and extended as the heavens and earth. Rain and fire were above him! At the sight of which Gudea is complĕtely awe-stricken and is forced to exclaim: Surely it is a god!—such impression this rain and fire made upon him. At his sides were, i. e., he was surrounded by "flying dark clouds" and was carried by a "stormflood," and

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[1] Z. A. XV. p. 49. [2] Delitzsch, H. W. B. p. 33.

[3] Cyl. A II. 9; Ur-sag ug zig-ga gab-shú-gar nu-tug dingir Nin-Gir-su, I would translate accordingly: Oh warrior, Oh furious tempest, who has no rival, Oh Nin-Gir-su! etc. Comp. also Cyl. A IX. 21 (Nin-Girsu) ur-sag-gal ki-dingir En-lil-lal-ka en gab-ri nu-tug, "the great hero in the domain of En-lil, the lord without equal."

[4] See also Cyl. A. VII. 4, 5, en-na shag an-gim sud-du-ni dingir Nin-Gir-su dumu dingir En-lil-lal, i. e., "the lord whose heart is as extended as the heavens: Nin-Gir-su, son of En-lil."

[5] Ri-ba = rib-ba (Thureau-Dangin, l. c. p. 51, note 3) = אחר. H. W. B. p. 159.

at his feet there were two "storms" or "tempests." The only god whom such a description fits is of course *Rammân.* That this Nin-Gir-su cannot be any other but Rammân is corroborated by the following considerations:

1. Nin-Gir-su has a special servant: the god Nin-sar who is called the gir-lal ^{dingir}Nin-Gir-su-ka.[1] Gir is=birqu, "lightning," "thunderbolt," and lal=nashû, "to lift up, carry," or=shapâku, "to pour out." Nin-Gir-su thus is not only the god of rain and storm, but also the god of lightning, or else he could not have a "thunderbolt carrier," who occasionally may "pour out" the thunderbolts. In old Babylonian times there also existed a ^{dingir}Nin-Gir,[2] who, no doubt, is the same as the ^{dingir}Nin-sar, for Nin-Gir means the "lord of the Gir or thunderbolts." The GIR or "thunderbolt" is also contained in Nin-GIR-su as well as in GIR-su! Even the bar-bar of ^{dingir}Im-gig-ghu-bar-bar indicates the brightness and flashes of the lightning or thunderbolts.[3] This is also the reason why I would read for A-NE=A-BIL.[4] Nin-Gir-su=Rammân appears unto Gudea in rain, storm, and fire, i. e., flashes of lightning.

2. The "dream" itself of Gudea speaks for our interpretation. The opening of Cylinder A describes the terrible drought of Girsu-Shirpurla, which can only come to an end by some pious deed of Gudea. And what is more natural for Gudea than to build a temple in honor of just the god of RAIN, storm, and lightning, that the drought might cease! And this god is Nin-Gir-su=^{dingir}Im-gig-ghu-bar-bar=Rammân, who promises thereupon that the drought shall cease after the temple has been built.[5]

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[1] Urakagina, Déc. XLIX.=E. B. H. p. 52, 23 (where we have to read for shag-lal=gir-lal as Déc. XLIX. clearly shows), so also E. B. H. p. 51 l. 14 ff. read: ^{dingir}Nin-sar gir-lal ^{dingir}Nin-su-gir-ra, and see already above, p. 590, 6.

[2] See the proper name Ur-^{dingir}Nin-gir, E. B. H. p. 413.

[3] See also Cyl. A. XI. 3, where E-ninnû is called ^{dingir}Im-gig-ghu an-sar-ra shegi-gì, "the Im-gig-ghu that flashes over the whole heaven," and comp. with this Thureau-Dangin, *Songe de Goudéa*, p. 14, note 1.

[4] Notice also that a *flame* (BIL) is Nin-Gir-su's sign. Cyl. A XII. 10.

[5] Thureau-Dangin, *Songe de Goudéa*, col. XI.! The rains will be announced by a wind, *ibid.*

3. If my interpretation be correct—and there can hardly be a doubt about its correctness—I would explain the dingir IM[1] the well-known ideogram for Rammân to be simply a further abbreviation of dingir Im-gig-ghu or dingir Im-gig-ghu-bar-bar respectively.

4. Now we also understand the so-called second triad of the Babylonian gods; they are ZU, UD, and X = Nin-Gir-su, or in Semitic: Sin, Shamash, and Rammân. This is the common sequence in which they occur. Sin is the head or abu,[2] Shamash his son, and Rammân is the 'am, the "father's brother." Here then we have the other racht! If the enumeration be: Sin, Rammân, Shamash,[3] it would be parallel to Anu, Ea, Bêl, i. e., the two brothers mentioned first, and then the son of the former.

The two triads of the Babylonian pantheon are two rachts and parallel to each other; they go back to the oldest times of the Babylonian history—another proof for the great age of the Sumerian civilisation!

dingir Ba-u, the wife of dingir Nin-Gir-su, had seven sons,[4] who were at the same time the "banda" of Nin-Gir-su.[5] What these "seven sons" stood for, is hard to tell. Three possibilities might be taken into consideration:

(1) They represent the seven planets.[6]

(2) The seven Igigi, or spirits of heaven.

(3) The seven winds or evil spirits, who are closely connected with Rammân.[7]

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[1] For references see E. B. H., Index, Gods, p. 443 sub I.

[2] This fact explains why Sin is called in the celebrated Moon-hymn (IV. R. 9) abu. He is the head, for this means "abu" here, of the racht. The abu = father (of the gods) is En-lil, as was seen above. See also Winckler, M. V. A. G., 1901, 4, p. 20. In later inscriptions the following gods are called abu ilâni; Bêl, Ashur Anu, Ea and Sin. See H. W. B. sub. abu, p. 3.

[3] As e. g. in the Black Obelisk of Shalmaneser II. ll. 6, 7.

[4] See above, p. 590, note 6. [5] Gudea, Cyl. B. XI. 4–12.

[6] That the Babylonians knew also of *seven* planets besides sun and moon, and not, as Winckler thinks, *always* of five only (with sun and moon = seven), is evident from the figures of the Kudurru of Nabu-shum-ishkun, now in the Berlin Museum. There we have "the sun," "the moon," "the morning star," and "the *seven* planets."

[7] See, e. g., IV. R. 5, 29 ff., Delitzsch, H. W. B. p. 33 sub. ûmu, and Winckler, *Der Alte Orient*, III. p. 95.

I myself would rather see in them the seven winds, cp. e. g., the name of the third son Ur-kalam-ta-ud-du-a, i. e., "the one who (a) goeth forth (ud-du) out of (ta) the foundation (ur = ishdu) of the earth (kalam), as such he, no doubt, is the same as the Gim-nun-ta-ud-du-a, "the one who goeth forth out of the abode or building (GIM) of the NUN (or ocean)," mentioned already by king Uru-ka-gi-na at about 4500 B. C.[1] Both would signify the "*east*-wind," as coming from the Persian Gulf. Nin-sar, too, would speak for the winds, storms, lightnings, that accompany Rammân. By Urukagina are also mentioned the Za-za-ru[2] or first son, the Im-pa-ud-du[3] or second son,[4] and the Nin-sar. This latter I take to be not only the same as the dingir Nin-gir but also as the dingir GHE (or GAN)-gir-nun-na—the one is the gir-lal, "thunderbolt carrier," the other is the "lord of the thunderbolt," and the third has at least something to do with the GIR as the name Ghe (or Gan)-GIR-nun-na indicates.[5] The fifth son Ghe (or GAN)-shag-ga probably is identical again with the Dun-shag-ga, who, as we have seen, is called "a son of Nin Gir-su."[6] Ka-úr-mu, the sixth, and Za-ar-mu, the seventh son, are known to me only from this passage.

The dingir Gàl-alim, from whom Gudea receives "dominion and a great scepter,"[7] and who, as we have seen, is also a son of Nin-Gir-su, I would like to identify with Nin-sar the gir-lal of Nin-Gir-su. Gudea, no doubt, wants to say by this, that he has received a scepter like that of Nin-sar, i. e., "a thunderbolt," by means of which he was able to *reign* and put down, if necessary, his enemies.

That some of the sons of dingir Ba-u are mentioned already by

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[1] E. B. H. p. 54. [2] E. B. H. p. 53. [3] E. B. H. p. 53.

[4] Is this Im-pa-ud-du perhaps identical with the Dun-pa-ud-da, E. B. H. p. 312, $31\frac{4}{2}$? See also Gin-dingir Dun-pa-ud-du and Ur-dingir Dun-pa-ud-du.

[5] The name of this god is also found in a shortened form, see E. B. H. p. 52, l. 27, where we have to read according to Déc. XLIX. [dingir GH]e (or [GA]N)-gir ki-ag dingir Nin-Gir-su-ka-ra.

[6] E. B. H. pp. 195, 196.

[7] Gudea, Statue B. II. 18, 19: nam-ner-gàl pa-magh sum-ma dingir Gàl-alim-ka-ge (K. B. III[1]. p. 28).

Uru-ka-gi-na,[1] shows that the whole system of the Babylonian theogony was fully developed as early as 4500 B. C.

This Nin-Gir-su, this god of lightning, thunder, rain, and storm, was "the warrior," or "mighty hero"[2] of Bêl or En-lil. En-lil has indeed a strong hero! From this follows, that whenever Bêl appears, he is accompanied by Nin-Gir-su, i. e., Bêl appears in company with lightning, thunder, and clouds. And who does not think instantly of the יהוה of the Old Testament who too appears in company of such an "ur-sag lig-ga?" Exod. xiv. 19 ff. we read (R. V.):

> "And the *angel of God*, which went before the camp of Israel, removed and went behind them: and *the pillar of cloud* removed from before them and stood behind them: and it came between the camp of Egypt and the camp of Israel: and there was the *cloud* and the *darkness*, yet gave it *light* by night."

Can we possibly have a more striking parallel to the dingir Nin-Gir-su ur-sag lig-ga dingir En-lil? The *ur-sag* or "warrior" corresponds to "*the angel.*" Nin-Gir-su is the ur-sag of *En-lil*, and here we have the "angel of *God*," i. e., יהוה! But "the angel" appears here under a *cloud.* Nin-Gir-su is called dingir Im, i. e., "*the cloud.*" The "cloud REMOVED from before them and stood behind them. dingir Nin-Gir-su is called "the *flying* Im-gig. This cloud was *darkness* and *light*, Nin-gir-su is called dingir Im-gig-ghu-bar-bar, i. e., "*dark cloud* flying, flashing up, or *very bright.*" Hence there cannot be any doubt that "the angel of God" is the ur-sag of יהוה and thus a striking parallel to the old dingir Nin Gir-su. But from this it also follows that יהוה himself is *no storm-god* as Stade[3] and Winckler[4] think, but the *storm-god* is "the angel" or the *ur-sag*, i. e., Nin-Gir-su, who accompanies En-lil or יהוה. En-lil or יהוה is the Bêl, "the Lord" *κατ' ἐξοχήν* must therefore necessarily be accompanied by his special "ur-sag" or "angel" and this is "the thundering and lightning dark cloud," hence יהוה is usually represented

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[1] Were it not for the fact that the "barrel-cylinder" is broken, we might have found mentioned on it all seven sons.

[2] The ur-sag, or ur-sag lig-ga, see above, pp. 590, 579.

[3] *Geschichte des Volkes Israels*, Vol. I., 429 ff.

[4] *Geschichte Israels*, Vol. I., p. 37 ff.

as coming in the company of just such a cloud.[1] En-lil as "king of heaven and earth" and "king of the gods" speaks and acts only through his ur-sag, i. e., lit. translated "head-servant," "prime-minister,"[2] so יהוה "the lord of hosts" speaks also through HIS "head-servant" or "prime minister": the מלאך—and what this "prime minister says or does, that says or does יהוה or En-lil. Hence we read Psalm xviii. 6 ff. (R. V.):

6. In my distress I called upon the Lord,
   And cried unto my God:
   He heard my voice out of his temple,
   And my cry before him came into his ears.[3]
7. Then the earth shook and trembled,
   The foundations also of the mountains moved
   And were shaken, because he was wroth.
8. There went up a smoke out of his nostrils,
   And fire out of his mouth devoured:
   Coals were kindled by it,
9. He bowed the heavens also and came down.[4]
   And[5] thick *darkness*[6] was under him,
10. And he rode upon a cherub, and did *fly*,[7]
    Yea, he *flew*[7] *swiftly* upon the *wings*[7] of the *wind*,[8]

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[1] See, e. g., Isaiah xix. 1 (swift cloud, R. V.); and the different passages about "the whirlwind."

[2] See here especially Gudea, Cyl. A. II. 11, 12:

dingir Nin-Gir-su zu-ab-a....
En-lil-ki-a (?) ner-gàl (?)

Which Thureau-Dangin translates (*Songe de Goudéa*, p. 116).

ô Nin-gir-su, toi qui dans l'abîme....
toi qui à Nippur es *au premier rang*.

Nippur is the city of *Enlil*, and there Nin-gir-su has "the premier rang," i. e., he is the ur-sag or מלאך, the "head-servant" or "prime-minister" of Bêl-Enlil.

[3] As soon as יהוה—En-lil hears the crying, he dispatches his "prime minister," the ur-sag. The ur-sag, taking here the place of יהוה—En-lil, because he *acts for* him,—comes under thundering and lightning.

[4] The ur-sag, so far thundering above, approaches the earth.

[5] The ur-sag is upon the earth, the poet sees him and describes him,—like Gudea of old!

[6] Comp. the a-ma-shub or "storm flood," and the IM-GIG of Nin-Girsu.

[7] Comp. the GHU, "flying," in Gudea's Imgig-GHU.

[8] Comp. the UG, "storm," "tempest," which are at Nin-Girsu's feet.

11. He made darkness his hiding-place, his pavilion round about him,[1]
Darkness[2] of the waters,[3] thick clouds of the skies.
12. At the brightness[4] before him his thick clouds passed,
Hailstones and coals of *fire*[4]
13. The Lord[5] also thundered in the heavens,
And the Most High uttered his voice:
Hailstones and coals of fire.
14. And he[6] sent out his *arrows* and scattered them;
Yea, *lightnings* manifold, and discomfited them.

That this description must be understood of the מלאך יהוה and not of יהוה himself, is evident from the "angel of god" in Genesis chapters 18 and 19, who speaks and acts like יהוה and who (he is called here simply יהוה) rains upon Sodom and Gomorrah *brimstone* and *fire* מאת יהוה מן השמים.[7] This "from heaven" is no gloss, as some commentators want it, but indicates that יהוה *himself* is somewhere else, while acting through his prime-minister or מלאך, who therefore, as his (Jahveh's) representative, is called יהוה too!

A further corroboration of this may be found in Gudea, Cyl. A IX. 20—X. 5,[8] where the "lugal A-MA-SHUB," the "king of the stormflood," is said to be dingir En-lil or Bel.

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[1] The Im-gig-ghu or "the flying dark clouds" surround Nin-Gir-su.

[2] Comp. the a-ma-shub or "storm-flood," and the IM-GIG of Nin-Girsu.

[3] Comp. the A or "water" which is "above" Nin-Gir-su.

[4] Comp. the BIL, "fire," that is "above" Nin-Gir-su, and the bar-bar in Im-gig-ghu-bar-bar.

[5] יהוה or En-lil through the "ur-sag."

[6] The "ur-sag" or "angel" or "prime-minister" makes use of his gir-lal, i. e., of dingir Nin-sar, bids him to pour out or send out (shapâku) his gir or "lightnings, thunderbolts."

[7] Gen. xix. 24.

[8] Translated by Thureau-Dangin, *Songe de Goudéa*, p. 125, as follows:

IX. 20. Moi je suis Nin-Gir-su qui *écarte*....
21. le grand héros auprès de Bel,
22. le seigneur sans rival;
23. mon temple (est) l'E-ninnû où moi....
24. mon arm le SHAR-UR qui sous son pouvoir réduit les contrées
25. mon IGI-GHUSH qui n'épargne rien au monde,
26. mon DA-BAT à qui personne n' échappe
X. 1. .....(This line reads: A-KU-mu nam-gal ki-ag-da)
2. "LE MAITRE DE L'OURAGAN (EST) BEL (!!)"
3. "son œil irrité (i. e., the IGI-GHUSH) n' épargne rien au monde"

The "weapons"[1] used by Nin-Gir-su and which are mentioned in the above-given passage, are no doubt the lightning, thunderbolt, etc., etc. There can be, then, no doubt that יהוה has his exact counterpart in dingir En-lil, and that the latter's ur-sag is the מלאך יהוה of the Old Testament. Thus יהוה is not a "*god of storm*," but "the lord who is accompanied *by* the storm,"—a difference!

But what or who is this dingir En-lil—יהוה? Hommel[2] takes dingir En-lil to be the "Herr der Luft," because LIL = zaqîqu[3] = Sturmwind, wind, and the kur-kur in lugal-kur-kur as signifying "die Berge des Luftreichs, die Wolken." This latter he derives from the signification of dingir Nin-char-sag and the surname of Bel: KUR-GAL, "the great mountain."[4] Against this might be said that a zaqîqu or *wind* is not yet "*air*," and that in later (Assyrian) inscriptions the lugal-kur-kur is always translated, not by shar shadê, but always ilu bêl mâtâti.[5] On accout of this latter translation LIL was taken to signify "the lord of the lands." The main attributes of Enlil were, as we have seen, "the king of heaven and earth," "the king of the lands," "the king of the gods," "the father of the gods." As time went on, these specific attributes of Enlil were applied even to other gods according to the influence they were able to exercise over the inhabitants of early Babylonia. Thus it happens that, e. g., the moon-god Sin had the following arrogant titles:

ilu Sin bêl ilâni sha shame-e u irtsi-tim
shar ilâni ilî (written ilu + pl.) sha ilâni
a-shi-ib shame-e rabûte.[6]

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4. "Nin-Gir-su guerrier de Bel"
5. de ces noms seront nommés.

[1] See also Gudea, Cyl. B VII. and Statue B V. 37; VI. 49 *et passim*.

[2] Identität, etc., p. 219.

[3] Ungar. lel anima, türk. yel, "Wind," Hommel, *ibid.*

[4] *Ibid.*, p. 220.

[5] See, e. g., Obelisk of Shalmaneser II., l. 3: ilu bêl-mâtâti ilu Bêl.

[6] "Sin, the lord of the gods of heaven and earth,
the king of the gods, the god of gods
that inhabit the great heavens."
Nabû-nâ'id, Thoncylinder aus Ur. A. W. p. 43. col. I. 28 ff. Sin is the bêl ilâni in as far as he is the "head" or ab of the second triad or racht, this also implies

Yes, when god Marduk occupied the most supreme place in the Babylonian pantheon, Nabû-nâ'id does not know how to honor him more than by calling him ^{dingir}EN-LIL ilâni ^{ilu}Marduk (AMAR-UD),[1] which is generally transcribed ^{ilu}bêl ilâni ^{ilu}Marduk, and translated "the lord of the gods, Marduk,"—the original, and no doubt intended signification however is: "the EN-LIL of the gods (viz.:) Marduk." By thus terming his supreme god, Nabû-nâ'id wanted to show that Marduk takes the place of EN-LIL of old.

Above we have seen that "heaven and earth" were considered by the old Babylonians to be closely connected, so closely as to require only *one* god; and if there was only *one* god for "heaven and earth," then this latter must have been considered as *one*. This *one* thing, this heaven-earth, AN-KI, has, when thus looked upon as *one* the name LIL. The first triad, when enumerated has mostly the sequence Anu, Bêl, Ea, i. e., Bêl is mentioned between his father and his 'am "father's-brother." That just *this* sequence should have become a stereotyped one must have a meaning. The explanation of this sequence no doubt is the following: AN "the heavenly ocean," and KI "the terrestrial ocean" are separated according to the Bible (Gen. i.) by the so-called רקיע (*raqî'a*) generally translated by "firmament," which latter is there "to keep back the waters of the heavenly ocean." This conception however is only one-sided. For we may very well ask, if the heavenly ocean is kept back by a רקיע, by what is the terrestrial ocean kept back?

And when Job[2] complains:

> "Am I a sea or a sea-monster
> That thou settest a watch over me,"

he did not think so much of a "heavenly sea or sea-monster" that is to be guarded, but of an *earthly* sea or sea-monster. Thus we would necessarily expect that there was also a רקיע for the terres-

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the "god of the gods." With ilî (= pl!) comp. also the *pluralis majestaticus* אלהים. But the "king of the gods" is an attribute of En-LIL.

[1] Nabû-nâ'id, Thoncylinder aus Sippar, A.-W. p. 40, col. I. l. 21.

[2] Chap. vii. 12.

trial ocean. The רקיע of the heavenly ocean is called "heaven."[1] The "heaven"[1] or "the firmament of heaven"[2] keeps back the waters above. The רקיע השמים itself proves that there must have been also another רקיע besides that of heaven—or else the השמים would, to say the least, be quite unnecessary. Thus, even P. still was under the impression that there existed a רקיע השמים and, of course, as we may conclude a רקיע הארץ. As the one רקיע is the "heaven," so the other רקיע is the "earth." This *one* רקיע that stands *between* the heavenly and terrestrial ocean, and keeps back the waters above the firmament as well as below the firmament is called by the Sumerians: LIL.

Thus we understand the succession: AN-LIL-KI or Anu, Bêl, Ea it stands for: the heavenly waters—the רקיע—the terrestrial ocean, by the רקיע they are divided, by it they also are kept back, the heavenly ocean by the רקיע which is the "*heaven*" and the terrestrial ocean, by the רקיע which is the "*earth*." Thus it also happened that according to P[3] the heaven had to have "windows" (ארבת השמים) through which the waters of the heavenly ocean could pour down at the time of the flood, and the "terrestrial ocean"—the תהום רבה as he calls it—had likewise to have some exit through which the waters might come, and these exits are the "wells" or מעינות. From this is also evident that not only the heavenly ocean was "kept back" but also the *terrestrial* ocean—the heavenly by the heaven and the terrestrial by the earth: heaven and earth thus form the רקיע or LIL. And EN-LIL standing between the AN and KI, i. e., "the heavenly and terrestrial ocean," becomes thus the רקיע, and the latter again under a twofold aspect: the heaven and earth—hence he is "the king of heaven and earth," or of the רקיע that stands between the AN and KI!

Having traced the genealogy of the gods and inquired into their specific meaning, we are now able to establish the following pedigree:

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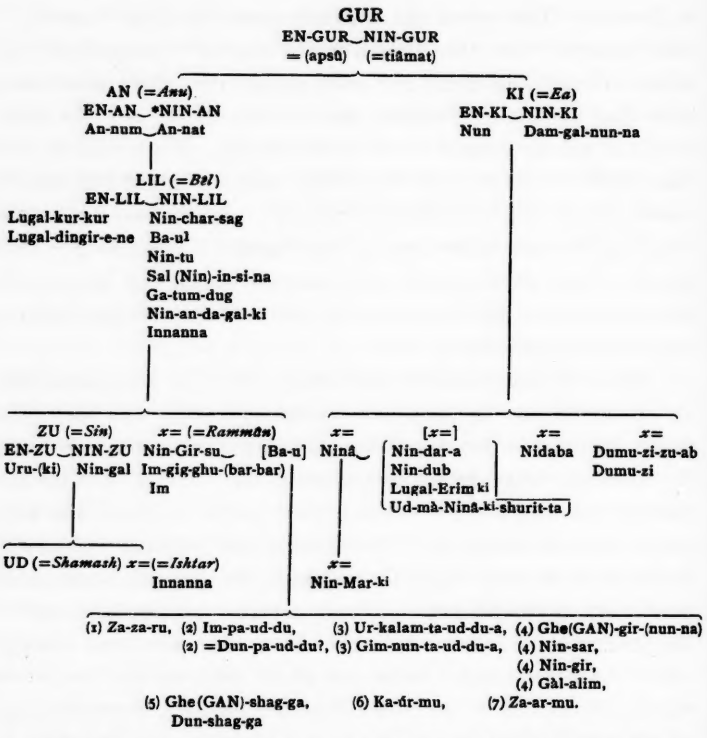
[1] ויקרא אלהים לרקיע שמים, Gen. i. 8.

[2] מארת ברקיע השמים, Gen. i. 14.

[3] Gen. vii. 11.



Of dingirNin-ib the pa-te-si-gal dingirEn-lil-lal-ge,[2] Nergal[3] or also known under the name dingirShit-lam-ta-ud-du-a,[4] and Nusku the lugh-magh dingirEn-lil-lal[5] we know too little to be able to classify them, if we want to do it according to the Old Babylonian inscriptions. Nabû does not occur at all.[6]

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[1] Other names for Ba-u to be found in Old Babylonian inscriptions are: Da-mu, Dun, Gu-la, Ma-ma, Nin-din-dug (probably to be read, however, Innanna-edin,) Za-ma-ma. See E. B. H. Index.

[2] E. B. H. p. 258_{22}.

[3] Written dingirGIR-UNUG-GAL, for this reading, and not: Nir-unug-gal, see Thureau-Dangin, Z. A. XV. p. 47, and note 2. For references see E. B. H. p. 226_3.

[4] E. B. H. 133_{30}, 224, 227_1. [5] E. B. H. p. 223, note 3.

[6] The inscription of Ardi-Na-bi-um belongs to a later (Canaanitish or Aramæan) period, as the name Ia-lu-un-a-sar shows. E. B. H. p. 229.

If we translate this genealogy and compare it with that of Gen. i. we would get the following result:

In the beginning there was a *chaos* which was thought to be a *male* and *female*, perhaps in one person. The Biblical name for this chaos was tohu-vabohu, but as male and female it was called either "waters" and "Tehom," or "Spirit of Elohim" and "darkness." In the Babylonian account the names apsû and tiâmat are used, while in the original Sumerian the chaos was simply called GUR which at one time or another was differentiated and became "Mr. Gur" and "Mrs. Gur," i. e., EN-GUR or NIN-GUR. From these first parents everything in heaven and upon earth took its origin. EN-GUR and NIN-GUR had two sons: AN and KI, i. e., they begot the "heavenly ocean" and the "terrestrial ocean." In the Babylonian-Semitic account the two sons were called AN-SAR and KI-SAR, who again probably correspond to the Lachmu and Lachamu. Genesis i., on the other hand, calls them "waters that are above the firmament" and "waters that are below the firmament." According to all three accounts, these waters take their origin from Tehom,[1] i. e., the descent is reckoned through the mother.

AN, the "heavenly ocean," has a son called LIL, i. e., the רקיע or firmament. The Sumerians reckoned, as it seems, to this firmament also the "earth," for it was divided into "heaven" and "earth," which served as barriers for the heavenly and terrestrial ocean. In the Bible, however, the earth or dry ground is born by the terrestrial ocean. This was, no doubt, also the Sumerian conception, for KI does not signify simply the terrestrial ocean but also the earth. It may not be impossible, however, that LIL was thought to be a son of both:[2] of AN and KI,—for both oceans were

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[1] See above, pp. 602, 576.

[2] This probably explains why Marduk, who was, as we have seen, identified with EN-LIL or Bel, is called the aplu rêshtû sha Ea, II. R. 64d, comp. with 17c. d. and in Damascius: τοῦ δὲ Ἄου (i. e., Ea) καὶ Δαύκης (i. e., Damkina) υἱὸς ὁ Βῆλος (i. e., according to later times the Bel κατ' ἐξοχήν: Marduk). See also Carus, *The Monist*, April, 1901, p. 406. That one son should have two fathers is not strange, it merely would presuppose polyandry with descent reckoned through the father. For a classical example see here the Minean inscription Hal. 504 = Hommel, *Südarabische Chrestomathie*, p. 94.

thought to be joined together beyond the firmament or רקיע,—this being simply the natural observation that the heaven rests upon the earth, and *mutatis mutandis*: the heavenly ocean upon the terrestrial. Remarkable also is that Ba-u together with LIL, her husband, are said to be "the firstborn" of AN,—surely an evident trace that the differentiation of the sexes was comparatively late. If LIL was the firstborn, then also his wife *had* to be the firstborn: both are thus husband and wife, and brother and sister.

The god LIL, by virtue of his being the רקיע or "heaven" and "earth," became the "*father*" and the "king of the gods of heaven and earth,"—not only of the gods, however, but also of all other creatures, as still may be seen from one of the attributes of his wife: Sal (Nin)-in-si-na who is called: "the mother of the world, the one who created the creatures of the world."[1] And as the attributes of the wife belong also to the husband, hence god LIL was, according to Sumerian conception, the creator or father of the *gods* and of the *creatures* of the world. The *gods* who are begotten by LIL are ZU or Sin, the moon-god, Rammân or Nin-Gir-su, "the thunderer" or simply "cloud," who again is the 'am of UD or Shamash, the sun-god, and Innanna or Ishtar, the morning or evening star. By Ba-u the wife of Rammân again are born the seven winds. Also according to Gen. i. "the two great lights and the stars" belong to the רקיע.[2] We now understand why P is so awfully afraid of naming these two great lights by name. He knew that they were the *sun* and the *moon*. He did not *want* to mention their names,—for if he did then he would have had to use for "sun" the Hebrew שמש (Shemesh), which apparently was too closely related to the Semitic-Babylonian Shamash and might have betrayed a heathenish origin of his (P's) whole cosmogony. The same may be said of Ishtar or עשתר! Shamash was at the time of P one of the *principal gods*,—and whatever smelled of heathenism was blotted out by P!

The terrestrial ocean according to the Sumerian cosmogony begets the fishes, the verdure, grain, etc. It ought to be noticed

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[1] E. B. H. p. 202, note I. 1.

[2] ברקיע השמים Gen. i. 14.

here that Ninâ or the fish-goddess is called the *sister* of Nin-Gir-su, hence stands with him on the same level. According to the genealogy given above, we would expect, however, that she would have been called the sister of LIL. This, no doubt, is due to the fact that LIL is the son, or was considered to be the son, of both AN and KI, thus standing between the latter two on one side and ZU, Rammân, and Ninâ on the other side. Also according to P the verdure, fishes, etc., etc., derive their origin from "the waters which are below the firmament," i. e. from KI!

Considering these striking similarities between the Biblical account of the creation story according to P and that of the Sumerians,—there can be no doubt, that the former is derived from the latter.

We would have to distinguish, then, in Genesis i. three different sources:

1. The *P source.* To this belongs the *system of seven days*, the *formula* given above and the different changes that were necessary in order to make the whole agree with the notions of P. The P source again was based upon

2. The *Semitic-Babylonian Creation Story.* This latter was used only in so far as it agreed with the conceptions—theological and otherwise—of P. All that was against P's conception was eliminated from it. While thus "*criticising*" the Semitic-Babylonian creation story, P quite unconsciously retained so much of it that he reproduced or came very near to the original

3. *Sumerian Source*, which source represented the creation not as the result of a *fight*, but as a natural process of *generation* and *perpetuation.*

Traces of No. 2 are: the conception of the original chaos as Tehom or darkness unto whom is opposed "the spirit of Elohim"; the *dividing* of the Tehom into the waters above and below the firmament, and last but not least, the אור or light,—the attribute of Marduk. To No. 3 belongs the *toledoth* or genealogy of heaven and earth, for the writer expressly says himself that what he has given in chapter one is a תולדות השמים והארץ, a generation and perpetuation of heaven and earth. In this sense תולדות *toledoth* has to

be understood, and thus we get a further corroboration of our statement that Gen. i. is not a "*creatio ex nihilo*," but a generation and perpetuation, a development out of the primeval chaos,—*an evolution.*

Thus the Biblical creation-story of P. is proved to be the redaction of a *Sumerian Theogony and Cosmogony.*

But where is Marduk? We have seen already above, that Marduk is not known in Babylonia *before* the time of the first dynasty of Babylon or about 2400 B. C. He then was imported by that dynasty which was of Canaanitish origin. Marduk therefore was probably a Canaanitish god. He was a *god of light.* The Canaanites seeing that there were in the Sumerian pantheon several gods of light as Sin, Shamash, Rammân, Ishtar, etc., made Marduk to be an "*attendant*," an AMAR of Shamash or UD—calling him AMAR-UD! This name expressed on one hand as nearly as possible the "*nature*" of the god, as well as on the other hand the sound of their own "*Marduk.*" When the Canaanites had in course of time subdued Babylonia and had made Babylon their capital with Marduk as the patron, Marduk became the *head* of all gods, "the king and father of the gods of heaven and earth," yes, he was called even *dingir EN-LIL*,[1] thus he not only became identified with god LIL, but all attributes belonging to EN-LIL originally, were now ascribed to Marduk. EN-LIL was, as we have seen, also the "father of all creatures and their creator"—hence Marduk became the creator too, and he being at the same time the god of light, it happened that the Creation was conceived of in later times to be a *fight between* Marduk the Creator and the darkness or Tehom. Marduk, the god of light, and his fight with Tehom or Tiâmat becomes thus a specific Babylonian-Semitic-Canaanitish production, hence also one of late origin.

P. by thus criticising and eliminating the mythical element of this fight of Marduk and Tehom, becomes thus the *first higher critic.* If he did not succeed in presenting to us the original pure Sumerian Theogony and Cosmogony, this was due to the fact that

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[1] See above, p. 618.

he *criticised* with a *purpose*—criticised the *Babylonian* Semitic account to adopt it to his own *theory* of the Creation in *seven* days in order to establish for his *Sabbath*—and thus for all his laws and ordinances connected with the Sabbath—the greatest possible age.

But let us be *thankful* to this first of all *higher critics:* he has made it possible for us to follow up his account and trace it to its original source. Thus we have another striking example of P.'s late age. He lived in Babylonia, was therefore able to acquaint himself with Babylonian ideas and gave us an account of the Creation which together with his "10 antediluvian fathers" may be traced to the very oldest sources at our disposal: to the Sumerian Cosmogony and Theogony.

HUGO RADAU.

WATERLOO, ILL.

EDITORIAL NOTE.

Owing to the exigencies of space, some important additions made by Dr. Radau to the preceding article had to be left out. These principally referred (1) to the attributes of Bêl (p. 619), (2) to Rammân-Nin-Gir-su, and (3) to the precedence of SIN. The explanations in question demand a consideration of the Sumerian cosmology and, as Dr. Radau's article is incomplete without them, they will appear in the October *Monist*.

BOOK REVIEWS.

LES PHILOSOPHIES NÉGATIVES. (Bibliothèque de philosophie contemporaine). Par *Ernst Naville*. Geneva: Georg & Cie.; Paris: Félix Alcan. 1900. Pp., 263. Price, 5 francs.

Prof. Ernest Naville, the famous Egyptologist and Swiss thinker, lays before the public his views on the negative philosophies, of which he enumerates seven: Scepticism, Traditionalism, Positivism, Dualism, Criticism, Mysticism, and Eclecticism. It is strange to find positivism among the negative philosophies, and also traditionalism, but a closer inspection of the author's meaning will satisfy the reader that he understands by positivism mainly Comte's positivism, which, insisting that we have no knowledge except what the positive sciences offer, practically negates religion and philosophy, establishing what we would call agnosticism. Positivism and agnosticism in the French-speaking world are actually identical, and thus we ought to replace positivism by agnosticism. Traditionalism certainly ought to be regarded as positive, but here our author keeps in mind that an adhesion to traditions to the neglect of the positive work of investigation negatives the exertion of the inquiring mind, and thus acts as a bane on man's spiritual life. Mysticism, too, is of a positive nature, yet our author distinguishes between that mysticism which is justified, or rather as he says harmless, suffering thinking to have its way and allowing science to assert itself; while another kind of mysticism is morally and intellectually subversive by antagonising the thinking faculty. Similar explanations are necessary to understand the author's meaning as to the sense in which he understands dualism, criticism, and eclecticism. Professor Naville embraces the monistic position, but he does not condemn that kind of dualism which he characterises as analytical dualism, which does not slur over contrasts, and is the condition of empirical science. The term criticism, too, is used in a special sense, and is characterised as that tendency in man which destroys and does not help to build up.

Altogether our author takes a position in which he accepts Christianity, not in the letter but in the spirit, identifying it with a spiritualised monism which accepts the freedom of will as the basis of practical morality. While, upon the whole, no one will seriously criticise our philosopher, we might find fault with his terms as

easily leading to misconceptions. While we would say that scepticism is negative, we find in criticism a negativism which is highly recommendable and desirable. It is not the positive which is to be accepted because it is positive, but we must distinguish between that which is wholesome and good and true, be it positive or negative, and that which is false, injurious, and dangerous. Traditionalism, viz., a thoughtless clinging to traditions, is positive and bad; while criticism (if we understand by it the principle of being on our guard and not allowing ourselves to take anything for granted that is untenable or unworthy of credence) is negative and yet wholesome.

Naville does not bring out his position very distinctly and clearly, but even this attitude is a trait of his character. We might almost say that he is too amiable to assert his position strongly, and though he seems to be an admirer of that which is positive, and is anxious to negate the negation, he rather lets us guess his position by indirection than states it positively and directly. P. C.

DAS PROBLEM DES WELTSTOFFS BEI GALILEI. Von *Ernst Goldbeck. Vierteljahrsschrift für wissenschaftliche Philos. und Sociol.*, XXVI. Leipsic: O. R. Reisland. 1902.

Ernst Goldbeck discusses Galileo's conception of the world-stuff, showing how Aristotle discriminated between crude matter which is of the earth earthy and a celestial substance which if it could exist in itself would remain eternal and perfect. The celestial substance suffers, however, through the admixture with matter. Galileo is the first naturalist who plainly and openly discarded the Aristotelian views, leading to the conclusion of the sameness of all substance. In this way Galileo became the founder of the monistic view, which has now become universally established in science. We might add that the Aristotelian notion of the celestial substance is based upon a truth, and although untenable in the form in which it was set forth, especially by the Schoolmen, the Aristotelians of the Middle Ages, there is no scientist who would doubt the significance of another element in reality which contains the conditions that in Aristotle's opinion deserve the name celestial; but this element, which to the Greek philosophers seem to be mixed up with matter, is not a substance of any kind but it is Kant's "purely formal"; it is that which conditions the formation of things, that which regulates the relations which obtain between the several objects of reality, the mathematics of physics. Though the purely formal is not a substance, it is the most significant part of reality, and the ancient philosophers may be excused for calling it a substance. Certainly if the purely formal is considered in itself, and not in its combination with matter, it is both eternal and perfect; its laws, which are irrefragable in theory, suffer many adaptations and seeming modifications in their application to the material world, and hence this justifies in the Aristotelian doctrine of matter modifying the eternal and perfect by rendering it transitory and imperfect. P. C.

RELIGIONSPHILOSOPHIE. Unter Mitwirkung des Verfassers aus dem Dänischen übersetzt von F. Bendixen. Von *Dr. Harald Höffding*. Leipzig: O. R. Reisland, 1901.

Dr. Harald Höffding, in his *Philosophy of Religion*, claims that all positive religions are untenable, but that the nucleus of religion is worthy as well as capable of preservation. Such is the fundamental idea of a voluminous work elaborated with the now fashionable method of the theorem of the conservation of values: "Satz von der Erhaltung der Werte." Dr. Höffding is well known to our readers as the ethicist of Copenhagen, and his books are distinguished by keen thought and a radical tendency. We would, however, criticise his expression as contradictory; if the positive religions are untenable, we should think their nucleus would be untenable too. If their nucleus is untenable, then there are positive features in the religions which would remain untenable. The difference here is a difference of expression. Dr. Höffding calls the positive element in religions the dogmas which have to be taken on credit, even though they are contradictory to science. To him a religion which is based on ideas which are not in conflict with science seems to be a negative religion; he adopts the word *positive* as used not by Comte but by dogmatists of the Churches, and we think the term would better have been avoided in this connection. What he wished to say might be better expressed thus: That though the dogmatic form of the several religions must be considered untenable, the underlying idea is capable and worthy of preservation; and this underlying idea would be that element of religion which would stand the test in the furnace of scientific criticism. P. C.

DER STREIT DER PSYCHOLOGISTEN UND FORMALISTEN IN DER MODERNEN LOGIK. Von *Dr. Melchior Palágyi*. Leipzig: Verlag von Wilhelm Engelmann. 1902. Pages, 93.

Whether one agrees or disagrees with the author's conclusions, the survey which Dr. Palágyi has given us of the discussions now being carried on between the psychological and the formalist or mathematical parties in modern logic will be suggestive reading. The author claims that the preponderating interest which was until recently taken in experimental and psychological research is waning, and that the foremost thinkers of to-day are turning their attention with increased zealousness to the questions of logic and epistemology. The pendulum has reached its point of highest psychological elevation, and has at last begun its movement toward the other side. And gratifying as this tendency of the intellectual movement may in some aspects be, it is yet, the author thinks, attended with danger. The "psychological peril," he says, has been replaced by the "formalistic peril"; and it is his mission, therefore, to restore equilibrium.

Dr. Palágyi's discussions are conducted in connection with animadversions on Husserl's *Logical Investigations*, which to him are symptomatic of the present conflict between psychologism and formalism. His criticisms are in one special

aspect also of value in calling attention to the important labors of Bolzano (1781–1848) whom the author regards as the legitimate founder of modern formalism. In a concluding chapter, Dr. Palágyi discusses his own position with regard to the relations obtaining between psychology and logic.

CONTRIBUTIONS TO A PSYCHOLOGICAL THEORY OF MUSIC. By *Max Meyer, Ph.D.*, Professor of Experimental Psychology. Published by the University of Missouri. 1901. Pages, 80. Price, 75 cents.

There appears to be considerable competition between the American universities in the publication of series of original studies in the various departments of research, and during the past year the University of Missouri has also joined the ranks of the publishers of original theses. The present series is edited by Dr. Frank Thilly, Professor of Philosophy, and the first work is the present study of a *Psychological Theory of Music*, by Dr. Max Meyer, Professor of Psychology. Dr. Meyer contends that musical theory, if it is to be at all scientific, must be psychological; it is a department of æsthetics, and neither the physicists nor the physiologists can prove by physical or physiological laws why we must enjoy certain combinations of tones. The physical and the physiological concepts have their proper functions, but the æsthetic significance of music can consist only in their relation to psychological concepts. Furthermore, the author contends that the most important group of musical facts is the one referred to by the scientific term "melody"; there may be music without rhythm (note that of the Oriental peoples), there may be music without harmony; but there can be no music without melody. This, therefore, must constitute the starting-point of the psychologists' investigations. The fundamental error in musical theory, according to the author, is that the basis of all music is the so-called diatonic scale. It is this view, he believes, that has prevented the development of a scientific theory of music.

LE BASI NATURALI DELLA POLITICA E DEL DIRITTO. By *Avv. Arturo Bruchi*. Pitigliano: Premiato Stabilimento Tipografico Osvaldo Paggi. 1902. Pages, 114. Price, L. 1.50.

In this little brochure, Signor Bruchi has concisely discussed the natural foundations of politics and law. Whatever may be the value of the author's conclusions, he is himself personally certainly not lacking in a species of grim humor. With a sort of premonition of the fate of his work, he dedicates it to his "Four Readers." He remarks that whoever cares to read it should do so, not with the desire to be diverted, but with the purpose of thinking profoundly. He begs whomsoever may have the hardihood to attack his little work not to begin at the end and read backward to the beginning, after the fashion of the Chinese, but to begin with the first letter of the first paragraph and to pursue his penitential task to the bitter end. Believing that these conditions will be too exacting for the great majority of modern readers, he has placed the mathematical limit of his reading public at the

number four. Why not seven, or three, or none, does not clearly appear from his argument. But from so candid a preface one is led to expect much, and it is quite likely that Signor Bruchi will find a much larger circle of readers than his gloom has anticipated. μκρκ.

LES PRINCIPES DE LA MÉCANIQUE RATIONELLE. Par *C. de Freycinet*, de l'Institut. Paris: Gauthier-Villars, Imprimeur-Libraire. 1902. Pp., viii, 167.

In his customary clear and simple style M. C. de Freycinet of the Institute of France has here endeavored to give to the world a study of the principles of rational mechanics which shall restore that science to its ancient dignity. The prevailing spirit of treating the principles of mechanics is an entirely abstract one. Real physical bodies are neglected and systems are constructed in which mass and force play the part of mere algebraic entities: postulates and axioms are propounded, and the movements are sought which these systems are constrained to take conformably to the initial hypotheses. As an eminent geometer has said: "The dualism between force and matter which crept into the ancient mechanics is by this expedient avoided."

Now, in M. de Freycinet's opinion, the new ways of procedure are not absolutely trustworthy, and are certainly not favorable to the discovery of new laws. He believes it wise to hold to the traditions of Galileo and Newton, D'Alembert, Laplace, and Lagrange, and if there is any change to be made in the methods hitherto reputed classical it is preferable to emphasise even more strongly the experimental character of the principles and to throw still more prominently into relief the *physical* data on which they rest. Unquestionably mechanics as thus set forth is a "mixture" of mathematics and observation, tinctured "with some ingredients of anthropomorphism." But what branch of human knowledge, asks M. de Freycinet, can escape a similar censure? Does not every science bear the imprint of our intellectual concepts, and outside the domain of pure logic the imprint also of our sensations of the external world? The fecundity and certitude of a science ought, on the contrary, to be in direct proportion to the intimacy of its contact with nature. M. de Freycinet has accordingly endeavored to strike out again on the roads which the present generation appears to be abandoning. Instead of endeavoring to extenuate in any way the supposititious deficiencies above signalised, he has deliberately augmented them by giving more and more place to empirical considerations. The mixture of observation with mathematics above referred to as indicating a lack of unity will here be rendered still more apparent, though with the distinct hope that the supposed confusion will be lessened. According to M. de Freycinet, the experimental data are the beginning and the reason of the analytical theories; they invest them with that reality without which the most brilliant achievements of analysis are futile.

The book is within the mental reach of any one who possesses an elementary knowledge of mechanics.

GRUNDZÜGE DER PHYSIOLOGISCHEN PSYCHOLOGIE. Von *Wilhelm Wundt*, Professor an der Universität zu Leipzig. Fünfte völlig umgearbeitete Auflage. Erster Band. Mit 156 Abbildungen im Text. Leipzig: Verlag von Wilhelm Engelmann. 1902. Pages, xv, 553. Price, bound, 13 Marks.

This is the fifth edition of Wundt's great pioneer work in the systematisation and exposition of the technical methods of experimental or physiological psychology. It has been almost entirely rewritten, and now occupies three instead of two volumes. The first edition appeared twenty-eight years ago, when the situation in psychological science was essentially different from what it is to-day. At that time Fechner's *Psychophysics* was the only work in which a successful attempt had been made to treat philosophical problems of a psychological import by exact methods. It was predominantly the physiology of the sensory and nervous systems that in those days supplied the material for the new science, while to-day enormous contributions from every department in any wise correlated with psychology are at hand. To-day there are few persons who deny the appropriateness of applying the exact methods of physical research to psychological fields; in fact, the matter has gone so far that opinions are not at all in consonance regarding the legitimacy of some of the new directions of inquiry in this direction. Wundt has followed all these changes, and has been compelled to take account of them in the revision of his work. His own views also have partially changed, and the outcome has been a work which, as its author claims, is in all essential respects a new one. Wundt's *Physiological Psychology* has exercised the greatest influence upon the development of his favorite science. His was for years the institute in which most of the psychological students of the world were educated, and the universal character of his talents and the variety of his studies always tended to impart great breadth to the researches in this field.

THE ETHICAL ASPECT OF LOTZE'S METAPHYSICS. By *Vida F. Moore, M. S., Ph. D.*, formerly Fellow of Cornell University. New York: The Macmillan Co. 1901. Pages, iv, 101.

This brochure is No. 4 of the Cornell Studies in Philosophy. The author has endeavored to emphasise a fundamental aspect of Lotze's philosophy to which too little attention has been devoted in the past. Lotze's doctrine of man, according to this pamphlet, rests upon the concepts of Personality and Teleology, which concepts grow out of the ultimate category of the Good. The starting-point and goal of his thought is the synthesis of the Good, Reality, and Truth into an organic whole. The Good is not evolved out of, or added to, Reality; it is the ground of all Reality. Reality is but the mode of its activity. All Lotze's characteristic metaphysical doctrines grow out of these conceptions. "The Good, defined as Personality, prescribes every tenet of his doctrine of the world, of man, and of God. Thus in his own system is embodied Lotze's conviction that the true beginning of metaphysics lies in ethics."

THE ELEMENTS OF PHYSICAL CHEMISTRY. By *Harry C. Jones*, Associate Professor of Physical Chemistry in the Johns Hopkins University. New York: The Macmillan Co.; London: Macmillan & Co., Ltd. 1902. Pages, xi, 565. Price, $4.00.

A new branch of science has come into existence within the last fifteen years. It occupies the ground between physics and chemistry, and bears the name of physical chemistry. New chairs for its advancement have been created in the universities, journals have been founded for its exposition, and a mass of technical literature has grown up around it. But to the general scientific and philosophical student it has remained a sealed book, and we therefore welcome the appearance of an elementary manual designed to place the results of this research within the reach of persons having an elementary knowledge of physics, chemistry, and mathematics. Of course, without the propædeutics of these three sciences it is impossible to approach the subject. To go at all deeply into it, the student must be familiar with the elementary calculus, and must have some knowledge of differential equations and the elements of thermodynamics. But even without these a fair knowledge of the field may be obtained.

Unlike some recent writers, the author of the present volume has not ignored the work of the older physical chemists, and he has devoted much space to the consideration of the labors of men like Kopp, Bunsen, and Regnault, and to the other great founders of chemical and physical science, it being his desire to prepare "a balanced book." It is to be hoped that his volume will contribute to the wide dissemination of the guiding ideas of this new branch of science, for they have extended into nearly every field of natural inquiry, including even, through the researches of Professor Loeb, the domain of biology. It will be no small source of pride to American readers of the book to learn that one of the principal contributions to the subject has been made by an American physicist, Prof. J. Willard Gibbs, of Yale. *μ.*

GESETZE ÜBER DAS URHEBERRECHT IN ALLEN LÄNDERN, nebst den darauf bezüglichen internationalen Verträgen und den Bestimmungen über das Verlagsrecht. Zweite Auflage. Durchgesehen von Professor Ernst Röthlisberger. Leipzig: Verlag von G. Hedeler. 1902. Pages, 418.

This work is a second edition of a valuable compilation of the copyright laws and treaties of all countries. The German text or translation of 250 different laws, treaties, instructions, etc., is given, and the revision of the volume has been undertaken by Prof. Ernst Röthlisberger, who as secretary of the Bernese International Bureau for Intellectual Property, is regarded as a foremost authority on copyright matters. The work has been brought down to date, the matter is alphabetically arranged, and a list of contents will be supplied gratis by the publisher. The book will be useful to all publishers and authors who need information on matters of international copyrights.

STUDENT'S PÂLI SERIES: PÂLI FIRST LESSONS. By *Rev. H. H. Tilbe, Ph, D.*, Professor of Pâli in Rangoon Baptist College. Rangoon: American Baptist Mission Press, 1902, 12mo., pp. x, 124.

This is the first Pâli Primer that has been published for Western students. We have had several Pâli grammars and even readers, such as the grammars of Clough, Minayeff, Kuhn and Müller, and the Readers of Elwell and Dines Anderson (though the last I have not yet seen); but for a genuine primer, where the beginner has everything explained step by step, the present little book is the first. It consists of six Jâtakas (Nos. 151–156) with literal translations and vocabularies. Each reading lesson is accompanied by a table of every word and grammatical form, making a number of short vocabularies. At the end there is a general vocabulary of forty pages. Roots are given and prefixes pointed out. The book is much better printed than the author's *Pâli Buddhism*, and I can recommend it to every beginner in Pâli. It would have been a great boon to myself in 1895, when I first took up that language. ALBERT J. EDMUNDS.

DIE TRANSCENDENTALE UND DIE PSYCHOLOGISCHE METHODE. Eine grundsätzliche Erörterung zur philosophischen Methodik. Von *Dr. Max F. Scheler*. Leipzig: Verlag der Dürr'schen Buchhandlung. 1900. Pages, 178. Price, 4 Marks.

Dr. Scheler has attempted in this volume an exhaustive discussion and exposition of what he regards as the philosophical method *par excellence*. He has endeavored to combine the transcendental method so called with the psychological method. The present situation is one that in the author's opinion imperatively demands a reconstruction of philosophical ways of procedure, and the question, as Dr. Scheler puts it, is not contained in Windelband's maxim that "To understand Kant is to transcend Kant," but rather "*How* shall Kant be transcended." That this has yet been done Dr. Scheler cannot bring himself to admit, even in the face of the many admirable contributions that have latterly been made to philosophy.

Under the influence of Professor Eucken, the philosophical method which Dr. Scheler has developed is termed the noölogical method. The following are some of the results: Apart from the principles of formal logic, there is no absolutely solid or self-evident datum from which philosophy in any of its forms may proceed. Neither the axioms of mathematics, nor theorems of physical science, nor "experience" in the transcendental sense, nor sensation, are entitled to lay claim to the dignity of such a datum. The transcendental method is quite inadequate for treating the problems of philosophy; so is the psychological method. The noölogical method is an attempt to combine the divergent methods of procedure of the transcendental philosophy and the transcendental psychology. Its fundamental concepts are: "World of work" (*Arbeitswelt*) and "form of spiritual life" (*Geistige Lebensform*). By "world of work" are understood the relations recognised as interconnecting the achievements of human civilisation; it is not in itself a self-

evident datum, but a "well-grounded phenomenon." Mind, and therefore also its constituent "intellect," is at the beginning of the quest for its contents a perfectly problematic conception. It is the x that renders the "world of work" possible. Inasmuch as the "world of work" is being continually enriched by the progress of human history, it is not possible to say precisely at any one point in history what the conception of mind is. A systematic deduction of *à priori* principles for "all possible experience" is impossible. The formal principles have too much contents to hold valid for all possible historical experience, and have too little contents to be vigorously applied in any actual historically-determined civilisation.

Such is the sum of Dr. Scheler's philosophy. It will be seen that it conforms in many respects to the spirit of our time, which is gradually drifting away from the anchorage of the formal philosophy of which Kant was the greatest exponent, and of that ideal of rigor which the stupendous development of the mathematical and physical sciences in the eighteenth and the first part of the nineteenth centuries had established as the goal of perfection which research in every department of human inquiry should strive to attain.

Dr. Scheler's work is not uninstructive reading, and his discussions of some of the present dilemmas in philosophy are not without value. *μ.*

THE UDANA, OR THE SOLEMN UTTERANCES OF THE BUDDHA. Translated from the Pâli by *Major-General D. M. Strong, C. B.* London: Luzac & Co. 1902. Pages, vii, 129. Price, 6 shillings net.

The *Udana* is a Buddhist book the significance of which has long been understood by Pâli scholars, and many important passages have been translated on various occasions by different scholars. Here we have for the first time an English translation which presents the whole of the book containing the solemn utterances of the Buddha. In a certain sense, the *Udana* ranks as high as the *Dhammapada*, which contains the moral code of the Buddhists, the *Sutta Nipata*, poems of instruction, the *Dhammachakkappavattana Sutta*, the story of the *Foundation of the Kingdom of Righteousness*, and kindred canonical scriptures. It is more philosophical than other books, and discusses the principal doctrines, such as the nature of enlightenment, the non-existence of the ego, or the âtman, the existence of the eternal, the nature of being, etc., etc.

General Strong in his introduction touches upon the most essential points of Buddhism, selecting the following: First, the three characteristics which are that all constituents of being are (1) transitory, (2) that they are misery, and (3) that they are lacking in an ego. Secondly, the only ideal that in the opinion of the Buddhist is worth striving after is the perfect life, or saintship, and this ideal is to be reached by emancipation from desire. Thirdly, salvation does not come by belief, but by keeping the precepts, as is stated in the famous lines: "To commit no evil, to do good, to purify the heart, that is the teaching of the Perfect One."

Fourthly, Nirvâna is the extinction in the heart of lust, ill will, and dulness or stupidity.

As to an "infinite first cause" (such is the expression of General Strong), Buddhism declares that "the Uncreate exists," and "if thou knowest the Uncreate, thou hast found deliverance."

The continuity of identity is constituted by Karma, or deeds, and Buddhism includes representations of a cyclic or evolutionary theory of existence, including the assumption of the origination and dissolution of innumerable solar systems.

A few quotations from General Strong's translation of the *Udana* will characterise the book:

"Purification cometh not by water, though the people bathe ever so long;
In whom truth and religion abide, that man is pure, he is a Brahmana."

"Whatever of sensual pleasure there may be on earth, or in the kingdom of the gods,
It is not worth a sixteenth part of the joy which springs from the destruction of Desire."

"He who seeking his own pleasure, does injury to the living,
For such a one there is no happiness hereafter.
But he who seeking his own pleasure, injures not the living,
For such a one there is happiness hereafter."

"Happy is that upright and learned one who has no possessions!
See how the rich man is troubled;
How one man is in bondage to another."

"As the mountain rock unshaken stands
So, delusion slain, the Bhikkhu
Like to a mountain, trembles not."

"He who keeps not watch over his body,
Who is under the spell of false doctrines,
Who succumbs to sloth and torpor,
Such a one passes into the power of the Tempter.
But he who keeps watch over his mind,
Whose sphere is right thoughts,
Who sets ever before him right doctrine,
Who knows the 'rise and set' of things,
Who overcomes sloth and torpor,
That Bhikkhu escapes from all states of punishment."

"It is easy for the good to do good,
It is hard for the good to do evil,
It is easy for the evil to do evil,
It is hard for the Saint to do evil." P. C.

LA PERCEPTION VISUELLE DE L'ESPACE. Par *B. Bourdon*, Professeur de Philosophie à l'Université de Rennes. Avec 143 Figures. Paris: Librairie C. Reinwald. 1902. Pages, 442.

A short sketch of the problem which Professor Bourdon has treated will be of value in determining the scope of his work. We are sensible by our organs of sight, of light and of colors on the one hand and of space, magnitudes, forms, position, movements, and depths on the other. The relative independence of these two groups of perception is easily shown; for the same forms continue to persist, whatever be the colors we impart to them; letters printed in blue retain the same shape as they would if they were printed in red. The perception of colors is retinal, which is not the case with the visual perception of space. This is produced by tactile, muscular, and articular sensations (coming mainly from the eyelids, the muscles of the eyes, the muscles which produce the movements of the head and the articulations concerned in these movements). Thus, when we fix our gaze upon an isolated point and perceive that it lies to our right, sensations other than those emanating from the retina must intervene in order to inform us of its position. For example, if the body and the head are at rest we must turn our eyes to the right to fixate this point, in which case determinate tactile and muscular sensations of the eyes must be produced. If the point afterwards passes to the left, and if we continue to fixate it, the image will not change its place upon the retina, but the tactile and muscular sensations will be modified, and will enable us to recognise that the point has passed to the right.

Now, it is to the study of such problems as the foregoing that Professor Bourdon's book is devoted. The book covers some four hundred pages and presents a comprehensive study of the visual perception of space. The author has endeavored to exhibit in a clear and simple manner the essential facts involved in this perception, to distinguish in the phenomena studied the part played by each cardinal species of sensations, and to fix this part quantitatively by numerous determinations. He has restricted himself almost entirely to fundamental points. His main thesis is that the perception of spatial depth by convergence is due to the sensations excited in the muscles of the eyes, and that the perception of positions to the right, to the left, above, and below, by means of changes in the direction of the gaze produced by simple movements of the eyes, is due to tactile sensations of the pupils. The author has drawn largely upon the work of the physiologists, like Hering, Helmholtz, Aubert, Volkmann, and Donders, and on that of psychological physicists like Mach. The book is well indexed and will serve admirably for orientation in the research of this field.

IL PENTIMENTO E LA MORALE ASCETICA. By *Zino Zini*. Torino: Fratelli Bocca, Editori. 1902. Pages, xii, 232. Price, L. 3.

The present volume, while devoted to a historical and comparative investigation of Christian and scientific ethics, is quite practical in its purpose. The author

avows that he has approached his subject in the impartial spirit of objective criticism and entirely without any preconceived notions. He believes that he has furnished ideas of value regarding the conflict of the old ascetic ethics with modern scientific ethics,—ideas, too, that are little known and that would be serviceable in the construction of a rational system of rules of conduct. There is a crying need, he says, of rescuing humanity from a system of ethics which is exclusively religious and which takes its origin neither in fundamental concepts nor in a scientific criticism of good and evil, and which is interpreted either in a traditional or ecclesiastical sense. Mankind must be furnished with a new system of ethical education, the foundations of which shall be reasoned convictions concerning the nature of good and evil, and the fruit of a broader and profounder knowledge of the causes and the laws controlling the actual moral facts. The author exhibits a wide acquaintance with both ecclesiastical and modern scientific literature. *μ.*

A HISTORY OF POLITICAL THEORIES ANCIENT AND MEDIÆVAL. By *William Archibald Dunning, Ph. D.*, Professor of History in Columbia University. New York: The Macmillan Co. 1902. Pages, xv, 360. Price, $2.50.

Professor Dunning attempts to supply in the present volume a decided want in the literature of political science, and in many respects he has admirably succeeded. There is no existing treatise which covers exactly the same ground. Scarcely any attention has been devoted either in England or America to the history of political theories, and one can point in these countries to no serious attempt "to trace out in origin and development the life of political ideas in the broad field of the world's progress." Blakey's *History of Political Literature* is characterised by Professor Dunning as "crude, scrappy, and superficial." Sir Frederick Pollock's *Introduction to the History of the Science of Politics*, while scholarly and adequate, is very brief. Surprising as it may be, not even in Germany, where the activity of scholars in all phases of historical research is enormous, does there exist a complete history of political theories. Mohl's useful work is little more than a classified bibliography of politics; Hildenbrand's excellent treatise was never completed, and the first volume reaches only to the close of classical antiquity. Bluntschli's solid production deals only with the period since the thirteenth century, and is devoted primarily to German literature; and lastly, Janet's "elaborate and most admirable work avowedly exhibits political theory in its relation to ethical doctrine."

Professor Dunning's aim, now, has been to be more comprehensive than Pollock, Bluntschli, and Hildenbrand, more systematic and accurate than Blakey, more historical and less bibliographical than Mohl, and, as contrasted with Janet, "to present rather an interpretation of the development of political theory in its relation to political fact." He has endeavored to trace through all antiquity and through the Middle Ages the history of all well-defined ideas "in reference to the origin, nature, and scope of the authority through which the relations of the mem-

bers of the community to one another are determined." He has excluded, however, primitive political theory, and limits his work to the philosophy of the European Aryan peoples. Thus, he has considered the constitutional basis of Greek theory, the political philosophy of Plato, the politics of Aristotle, the political theory of later Greece and of Rome, the development of Mediæval institutions, political theory in the early Church, the theories current during the development of ecclesiastical hegemony, the political philosophy of St. Thomas Aquinas and his school, the theories which were rife during the decline of the Papal hegemony, the passing of the Middle Ages, and finally, he has devoted a considerable chapter to Macchiavelli.

The select references to literature and the bibliography afford excellent guides to the student, and there is a good index. *μ.*

L'IMAGINATION ET LES MATHÉMATIQUES SELON DESCARTES. Par *Pierre Boutroux*, Licencié ès lettres. Paris: Ancienne Librairie Germer Baillière. Félix Alcan, Éditeur, 108 Boulevard Saint-Germain. 1900. Pages, 45.

Analytical geometry constituting the most distinctive and glorious achievement of the French philosopher Descartes, and the object of that branch of mathematics being to eliminate visualisation altogether from geometry and to subject its development to the mechanical operations of algebraic machinery, it has been quite generally supposed that Descartes actually proposed to restrict to the utmost the part played by imagination in mathematical inquiry. Reason alone, he is said to have contended, can arrive at knowledge in the truest sense of the term, and as Comte has remarked, this principle is the very gist and essence of analytical geometry. On the other hand, a passage is found in the second part of the *Regulæ* treating of applied logic, where it is said that imagination is the indispensable auxiliary of reason. Here, therefore, is an apparent contradiction which it has been the purpose of M. Boutroux to remove in this little pamphlet published in the Library of the Faculty of Letters of the University of Paris. The author shows that the foundations of Descartes's mathematical method are contained in his metaphysical principles, and that the philosopher's attitude toward the problem here at issue is determined by the general philosophic attitude which he took with regard to the question of the relation between "body and soul" conceived as two distinct substances. *μ.*

A. VON KÖLLIKERS STELLUNG ZUR DESCENDENZLEHRE. Ein Beitrag zur Geschichte moderner Naturphilosophie. Von *Dr. Remigius Stölzle*, ö. o. Professor der Philosophie an der Universität Würzburg. Münster, i. W.: Druck und Verlag der Aschendorffschen Buchhandlung. 1901. Pages, 172. Price, 2 Marks.

Some years ago, we devoted several pages of *The Monist* (Vol. VIII., p. 150 et seq.) to the consideration of Dr. Stölzle's book on Karl Ernst von Baer. Dr.

Stölzle there exhaustively considered the scientific attitude of the great embryologist toward Darwin's theory of descent, and made use of Baer's position for the purpose of repudiating Darwin's theories. He has now attempted a similar task in connection with the work of the biologist Kölliker.

Dr. Stölzle believes in the theory of descent as an hypothesis of a high order of probability, but as a dogma nevertheless. The weight of the evidence, however, is so overwhelming that even Dr. Stölzle admits that there is nothing at present militating against it in its general and purely logical formulation. He has turned therefore to the controversies which center about the *causes* which have been assigned as adequate for the formation of new species. Are these causes internal or external causes? Is the explanatory factor the "selection" of Darwin, the use or non-use of Lamarck, and so on? Here, he remarks, is where confusion reigns, and here let us also remark is the point at which the reactionary thought of the day takes its stand. It is nothing short of amusing to observe how Dr. Stölzle has selected for criticism from Kölliker's labors the points which militate against his own philosophical position, and how he chooses for commendation the doctrines which make for its maintenance. For example, as errors of Kölliker are mentioned his mechanical conception of the universe, his denial of teleological principles, and his denial of the necessity of a creator. Of enduring value and exemplars of truth are his critique of Darwinism, his acceptance of interior causes, and his assertion that all theories of descent were possibilities only and could never hope to acquire the full evidence of experiments admitting of repetition.

But entirely apart from the "purpose" that pervades Dr. Stölzle's book, his review of Kölliker's labors will be of value to students who are desirous of obtaining within brief compass a synoptic view of the work of one of the most prominent of modern biologists. *μ.*

TYPICAL MODERN CONCEPTIONS OF GOD, or The Absolute of German Romantic Idealism and of English Evolutionary Agnosticism. With a Constructive Essay. By *Joseph Alexander Leighton*, Professor of Philosophy in Hobart College. New York: Longmans, Green & Co. 1901. Pages, xii, 190. Price, $1.10.

Professor Leighton has gathered together in this volume certain philosophical essays which he published in *The Philosophical Review* and had previously submitted in another form to the faculty of Cornell University in partial fulfilment of the requirements for the degree of doctor of philosophy. He has considered the theologic views of four philosophers, viz., Fichte, Hegel, Schleiermacher, and Spencer, whom he has selected "because of the typical and partially complementary character of their respective treatments of the problem of the Absolute—the problem of the metaphysical conception of God." To each of these philosophers he has devoted a chapter; the concluding essay of the work being an outline-treatment of the problems which most troubled Professor Leighton's mind during his

studies, viz., "the problem of the relation of the One and the Many, and even more prominently the relation of the Absolute to Time."

The discussion is entirely of the ultra-metaphysical sort, and is concerned with the ontological difficulties which have perplexed the philosophers of absolutism from the beginning of all time; such "apparently insoluble contradictions," for example, as that of "a time world and a Timeless Absolute," of a "progress in finite intelligence and an unchanging Absolute Individual as the ground of this progress," etc., etc. μ.

PHILOSOPHENWEGE, AUSBLICKE UND RÜCKBLICKE. Von *Karl Joël*, Professor an der Universität Basel. Berlin: R. Gaertners Verlagsbuchhandlung, Hermann Heyfelder. 1901. Pages, x, 308. Price, 6 M. Bound, 7 M.

Professor Joël, who holds the chair of philosophy in the University of Basel, the same who wrote a book on the genuine and the Xenophontic Socrates, has written a book entitled: *The Ways of a Philosopher; Outlooks and Retrospects*, in which he speaks in an easy and pleasing style of the future of philosophy, the age of ethics, the new spirit, the heart of science, the battle arrays of power and love, women in philosophy, philosophical marriage, the sphinx of pessimism, Stirner (a prominent advocate of Nietzsche's philosophy), and philosophy and poetry.

L'ANNÉE BIOLOGIQUE. COMTES RENDUS ANNUELS DES TRAVAUX DE BIOLOGIE GÉNÉRALE. Publiés sous la direction de *Yves Delage*, Membre de l'Institut, Professeur a la Sorbonne, Directeur de la Station Zoologique de Roscoff. Avec la collaboration d'un Comité de Rédacteurs. Secrétaire de la Rédaction Alphonse Labbé, Chef des travaux de Zoologie à la Faculté des Sciences de Paris. Cinquième Année 1899–1900. Paris: Librairie C. Reinwald. 1901. Pages, lxxvi, 676.

The enormity of their task of digesting and cataloguing the biological literature of each year appears to have dawned forcibly upon the editors of the *Année Biologique*, and they have in the present volume compressed the labors of nearly two years, bringing the work in all essential respects down to the close of the year 1900. They have been obliged, however, to defer the publication of the botanical portion until the coming year. Thanks to a more rigorous control of the reviews and analytical summaries, and to the strict elimination of what does not directly concern biology, the present volume, although covering two years, is not larger nor more expensive than its predecessors. The editor hopes in this way to publish future volumes promptly, with less expenditure of labor and space, and to fulfil precisely the same purposes. The reader will find in this book, which is indispensable to workers in biology and to all who have occasion in other sciences to consult biological literature, all the references and bibliographical information that he is ever likely to need. μ.

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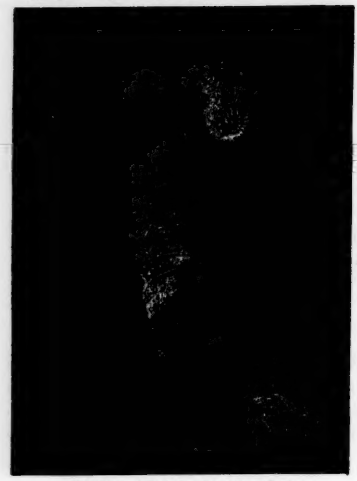

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